Engineering Library

MAR 25 1929

The Engineer.

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VOL. CXLVII.—No. 3817] LONDON: FRIDAY EVENING, MARCH 8, 1929 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

Crown Agents for the COLONIES.

COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POSTS :—

M/1366.—CIVIL ENGINEER REQUIRED by the GOVERNMENT of NIGERIA for Bridge Construction, for a tour of 12 to 18 months' service, with possible extension. Salary, £720, rising to £920 a year by annual increments of £40. Free quarters and passages and liberal leave on full salary. Candidates, not over 40 years of age, must be fully qualified Civil Engineers, should have had experience of Screw Piling and General Steel Constructional Work.

M/994.—CIVIL ENGINEER REQUIRED by the GOVERNMENT of SIERRA LEONE, for the PUBLIC WORKS DEPARTMENT, for two tours of 12 to 18 months' service, with possible extension. Salary £600, rising by annual increments to £920 a year; outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, 30 to 35 years of age, must have passed Sections A and B of the Examination to qualify for the A.M.I.C.E. Diploma or hold professional qualifications accepted by the Institution of Civil Engineers as exempting from these examinations. Must be good Draughtsmen, capable of Designing and Carrying-out Buildings, Bridges, and other Engineering Structures and of Taking-out Quantities and Preparing Detailed Plans and Estimates. They must be competent to Execute Surveys and to Lay-out and Construct Roads and should have had practice and general experience as Civil Engineers in Construction of Roads, Buildings, and other Public Works.

M/732.—CIVIL ENGINEER REQUIRED by the GOVERNMENT of CEYLON, for APPOINTMENT as IRRIGATION ENGINEER, for three years' service and prospect of permanency. Salary £500, rising to £900 a year by annual increments of £40 (£600 a year on attaining 30 years of age). Free quarters and free passages provided. Candidates, unmarried, 28 to 31 years of age, must have passed examination to qualify for Associate Membership of the Institution of Civil Engineers or hold professional qualifications recognised by the Institution as exempting from Parts A and B of that examination, and have had at least three years' practical experience on Waterworks, Drainage or Harbour and Dock Works.

M/1313.—CIVIL ENGINEER REQUIRED by the MOSUL MUNICIPALITY in IRAQ for three years' service in the first instance. The rate of salary will depend upon the qualifications and experience of the officer selected, but will not exceed Rupees 1200 a month. Free passages. Candidates, about 35 years of age, must be fully qualified Civil Engineers, and must have had extensive experience of Water Supply and Electric Plant, also of Roadmaking and Maintenance, and of Town Planning. Preference given to candidates who have had practical and responsible experience in one of the larger municipalities in the United Kingdom.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting the reference number against the appointment for which application is made. 1236

Ministry of Transport.

ROADS DEPARTMENT.

APPLICATIONS are INVITED for a TEMPORARY APPOINTMENT as a JUNIOR CIVIL ENGINEERING DRAUGHTSMAN in the Roads Department of the Ministry of Transport at Whitehall, at a commencing wage of £3 per week.

Forms of application can be obtained from the Establishment Officer, Ministry of Transport, 6, Whitehall-gardens, S.W. 1. Applications can only be received on the recognised forms, and should reach the MINISTRY OF TRANSPORT on or before the 15th March, 1929. Preference will be given to candidates who have served in His Majesty's Forces. 1219

Armstrong College,

NEWCASTLE-UPON-TYNE.

(IN THE UNIVERSITY OF DURHAM.)

COURSES for the PASS DEGREE of B.Sc. and the HONOURS DEGREE of B.Sc. in MECHANICAL, MARINE, CIVIL or ELECTRICAL ENGINEERING, MINING, METALLURGY, or NAVAL ARCHITECTURE. The curricula of the Pass Degree and the Honours Degree normally occupy periods of three and four years respectively, but candidates presenting evidence of sufficient previous training may be allowed to proceed to either Degree after two years' residence.

The engineering laboratories have recently been extended, and all Departments are equipped for advanced tutorial and research work.

Full particulars of the Courses may be had on application to

THE REGISTRAR,
Armstrong College,
223 Newcastle-upon-Tyne.

In the High Court of Justice. 1929.S.01.
Chancery Division.
Mr. Justice Clauson.
In the Matter of SPENCER-BONECOURT LIMITED AND REDUCED
and
In the Matter of THE COMPANIES (CONSOLIDATION) ACT, 1908.

Notice is Hereby Given that the

ORDER of the HIGH COURT OF JUSTICE CHANCERY DIVISION dated the 20th February 1929 CONFIRMING the REDUCTION of the CAPITAL of the above-named COMPANY from £120,000 to £48,000 and the MINUTE approved by the Court showing with respect to the Share Capital of the Company as altered the several particulars required by the above Act WERE REGISTERED by the Registrar of Companies on the 5th day of MARCH 1929.

Dated this 5th day of March 1929.

NICHOLLS and CO.,
17, Farringdon-street,
London, E.C. 4,
1223 Solicitors for the said Company.

The Engineer

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PUBLIC NOTICES

Heriot-Watt College,

EDINBURGH.

PROFESSOR OF MECHANICAL ENGINEERING.

The Governors invite APPLICATION for the PROFESSORSHIP of MECHANICAL ENGINEERING, which will shortly become vacant owing to the retirement of Professor Richard Stanfield, M. Inst. C.E., A.R.S.M.

The Professor is head of the Mechanical Engineering Department, which includes Day Courses of University standard and Evening Courses of study. The person appointed will be required to take up his duties on 1st September, 1929. Salary £1000 by £50 to £1200. Particulars may be obtained from the Principal at the College, to whom applications should be sent by 16th March.

J. CAMERON SMAIL, O.B.E.,
949 Principal.

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for :—

ONE 5-TON OVERHEAD ELECTRIC TRAVELLING CRANE.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Tuesday, 5th March, 1929.

A fee of 10s. will be charged for each copy of the specification, which is NOT returnable.

Tenders must be submitted not later than Noon on Friday, 15th March, 1929.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
R. C. VOLKERS,
1188 Secretary.

Borough of Hove.

TENDERS are INVITED for PROVIDING and FIXING a LANCASHIRE BOILER at Hove Baths, King's Esplanade.

Further particulars and specification may be obtained from the Borough Surveyor's office.

The lowest or any Tender not necessarily accepted.

Tenders, on forms supplied, addressed to the undersigned and endorsed "Tender for Boiler," will be received up to Five o'clock on Wednesday, the 27th March instant.

W. JERMYN HARRISON,
Town Clerk.

Town Hall, Hove,
4th March, 1929. 1196

PUBLIC NOTICES

City and County of Kingston-upon-Hull.

ELECTRICITY DEPARTMENT.

The Electricity Committee of the above invite TENDERS for :—

ONE TWO MILLION GALLONS PER HOUR ELECTRICALLY DRIVEN CIRCULATING WATER PUMP, MOTOR, MOTOR STARTER, &c.

Tender forms, general conditions, specification and drawings can be obtained upon application to the undersigned on payment of One Guinea for each specification, which amount will be returnable on receipt of a bona fide Tender.

Additional copies may be had at a cost of Ten Shillings each, not returnable.

Cheques and postal orders to be made payable to the City Treasurer, Guildhall, Hull.

The Corporation does not bind itself to accept the lowest or any Tender.

Tenders to be addressed to :—
The Chairman, Electricity Committee,
Town Clerk's Office,
Guildhall, Hull,
endorsed "Contract 138," and must be delivered to the above address not later than Noon, Thursday, March 21st, 1929.

J. N. WAITE, M.I.E.E., F.I.F.,
City Electrical Engineer and Manager.
Electricity Works,
Sculcoates-lane, Hull,
February, 1929. 1103

Southampton Corporation

WATERWORKS.

TO CONTRACTORS AND OTHERS.

The Corporation invite TENDERS for the LAYING and JOINTING of about 9400 YARDS of 24in. and 2100 YARDS of 15in. WATER MAINS from Romsey to Millbrook.

Plans may be seen and specification, bill of quantities and form of Tender obtained at the Waterworks Engineer's office, 21, Shirley-road, Southampton, upon production of the Borough Treasurer's receipt for a deposit of £3 3s. Deposits will be returned after the Council have dealt with the Tenders to contractors who have submitted bona fide Tenders.

Sealed Tenders, endorsed "24in. and 15in. Water Mains," on the prescribed form, together with priced quantities and schedule, must be delivered at the Town Clerk's Office, Southampton, on or before the 15th March, 1929.

The Council do not bind themselves to accept the lowest or any Tender.

R. R. LINTHORNE,
Town Clerk.
2nd March, 1929. 1191

PUBLIC NOTICES

Southampton Corporation

WATERWORKS.

CAST IRON OR STEEL PIPES AND SPECIAL FITTINGS.

The Southampton Corporation invite TENDERS for the SUPPLY of about 9400 YARDS of 24in. PIPES, about 2100 YARDS of 15in. PIPES, and about 50 TONS of C.I. SPECIALS, or the equivalent weight of STEEL SPECIALS.

Specification, schedule and form of Tender may be obtained at the Waterworks Engineer's Office, 21, Shirley-road, Southampton.

Sealed Tenders, endorsed "Tender for 24in. and 15in. Pipes and Specials," must be delivered at the Town Clerk's Office, Southampton, by Ten o'clock in the forenoon of the 15th March, 1929.

Tenders from British manufacturers only will be considered.

No pledge is given to accept any Tender.

R. R. LINTHORNE,
Town Clerk.
2nd March, 1929. 1192

Southampton Corporation

WATERWORKS.

SLUICE VALVES.

The Corporation invite TENDERS for the SUPPLY of HEAVY CAST IRON DOUBLE-SOCKET and DOUBLE-FLANGED SLUICE VALVES, 12in. to 6in. diameters.

Particulars can be obtained at the Waterworks Engineer's Office, 21, Shirley-road, Southampton.

Sealed Tenders, endorsed "12in. to 6in. Sluice Valves," to be delivered at the Town Clerk's office on or before the 15th March, 1929.

The Council do not bind themselves to accept the lowest or any Tender.

R. R. LINTHORNE,
Town Clerk.
2nd March, 1929. 1193

South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

1. POINTS and CROSSINGS, &c., "A."
2. STEEL BEARING PLATES for F.B. RAILS.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Points and Crossings, &c., 'A,'" or as the case may be, with the name of the firm tendering, must be left with the undersigned not later than Twelve Noon on Friday, 22nd March, 1929.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 5s. for each copy of Specification No. 1, and of 2s. 6d. for each copy of Specification No. 2.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.
91, Petty France, Westminster, S.W. 1.
6th March, 1929. 1238

The Madras and Southern MAHRATTA RAILWAY COMPANY, Limited,

invite TENDERS for—

(i) 62,000 FISH BOLTS (various sizes) (approximate total weight equals 50 tons).
(ii) 227,600 STEEL DOGSPIKES (various sizes) (approximate total weight equals 67 tons).
(iii) 39,400 STEEL BEARING PLATES (various sizes) (approximate total weight equals 137 tons).
(iv) PAPER (Printings, Wrappings), &c. &c.
(v) ONE 50-Ton STEAM BREAKDOWN CRANE, with MATCH TRUCK.

Tenders for (i) to (iv) are due in on Tuesday, 26th March, and for (v) on Tuesday, 9th April, 1929, by 2.00 p.m.

Tender forms obtainable at the Company's Office. Fee (i) and (ii) HALF A GUINEA, (iii) to (v) ONE GUINEA, WHICH IS NOT RETURNABLE.

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices,
25, Buckingham Palace-road,
Westminster, S.W. 1. 1224

The Tralee and Fenit Harbour

Commissioners invite TENDERS for the PROVISION and ERECTION of COLD STORAGE ACCOMMODATION at Fenit, in accordance with the plans and specifications, copies of which can be had on application to the undersigned.

Sealed Tenders to reach me not later than 14th March, 1929.

The lowest or any Tender not necessarily accepted.

J. LAWLOR,
Secretary.
Harbour Offices, Tralee. 1097

The Directors of the Egham and Staines Electricity Company, Ltd., are

prepared to receive OFFERS for :—

ONE 500 B.H.P. English Electric DIESEL ENGINE direct coupled to ONE 2200-Volt, Single-phase, 50 Cycles ALTERNATOR.

Particulars of the plant from the MANAGER, Electricity Works, Staines. 1187

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PUBLIC NOTICES

Egyptian Government.

APPOINTMENT OF A BOILER INSPECTOR.

APPLICATIONS are INVITED for APPOINTMENT as a BOILER INSPECTOR in the Mechanical Department of the Egyptian State Railways, Telegraph and Telephone Administration.

Applicants must be of British nationality, between 30 and 40 years of age, preferably unmarried, and possess the following qualifications :—

Must have served a regular apprenticeship either with a Railway Company or a firm of Locomotive Builders.

Must be fully qualified to examine and report on the condition of boilers.

Must have had wide experience in the Boiler Building and Repair Work.

Must have had experience in control of men.

In addition to experience in Boiler Work, experience in the Running Dept. of a Railway is necessary.

Salary £E480 per annum (£E1 equals £1 0s. 6d. approximately), free of Egyptian income tax.

The appointment is subject to medical examination.

The selected candidate will be granted a transfer allowance equal to one month's salary for change of residence from England to Egypt and also vice versa.

Period of contract to terminate on 20th September, 1930.

Third-class fares and reasonable out-of-pocket expenses will be paid to applicants who are requested to attend for interview and/or medical examination.

Application and specimen contract forms may be obtained from the

CHIEF INSPECTING ENGINEER,
Egyptian Government,
41, Tothill-street, London, S.W. 1,

to whom they should be returned, with full particulars as to education, qualifications, previous experience, personal references, and copies of certificates or testimonials.

Envelopes to be endorsed "Boiler Inspector." 1174

Metropolitan Water Board.

APPOINTMENT OF TWO MECHANICAL ENGINEERING DRAUGHTSMEN.

The Metropolitan Water Board invite APPLICATIONS for the above-mentioned APPOINTMENTS at a commencing salary of £215 per annum, rising by annual increments of £15 to £260 per annum, plus a fluctuating "cost-of-living" bonus, which on a salary of £215 amounts at the present time to £102 12s. 11d. per annum. The bonus is payable pending further order by the Board.

Candidates should have had workshop and drawing-office experience, preferably in the construction and design of waterworks pumping machinery.

The successful candidates will be required to pass a medical examination and to undertake to contribute to the Board's Superannuation and Provident Fund.

Applications, in candidate's own handwriting, stating age and full particulars of training, experience and qualifications, should be addressed to Mr. Henry E. Stilgoe, M. Inst. C.E., Chief Engineer, and must reach the offices of the Board not later than Monday, 25th March, 1929.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board.
173 Rosebery-avenue, E.C. 1.
23rd February, 1929. 1102

Park Prewett Mental Hospital,

BASINGSTOKE, HANTS.
ASSISTANT ENGINEER.

APPLICATIONS are INVITED for the POST of ASSISTANT ENGINEER, capable of preparing drawings, taking out estimates for buildings and improvements. Must have a good knowledge of Steam and Electrical Plant and able to keep work costs. Salary commencing at £200, with house valued at £30 per annum, rising to £245, subject to satisfactory service.

Age last birthday not to exceed 34 years.

The appointment will be subject to the provisions of the Asylums Officers' Superannuation Act, 1909.

Applications, stating age, experience and qualifications, must be sent to the MEDICAL SUPERINTENDENT on or before Monday, 18th March, 1929, together with copies of three recent testimonials, envelope to be marked "A.E." 1183

Shanghai Municipal Electricity Department.

STAFF APPOINTMENTS.

The Electricity Department of the Council REQUIRES the SERVICES of ONE SYSTEM CONTROL ENGINEER and TWO ASSISTANT SHIFT CHARGE ENGINEERS.

(A) SYSTEM CONTROL ENGINEER.—The successful applicant would, whilst on shift, be responsible for directing all switching and operating on the distribution system in order to keep familiar with the system he may be required to act for alternate periods as a Distribution Engineering Assistant.

Applications will only be considered from those having the following qualifications :—

AGE.—Not exceeding 35 years.

TECHNICAL EDUCATION.—Equivalent to I.E.E. examination for Associate Membership.

PRACTICAL TRAINING.—Must have served an apprenticeship with some electrical engineering concern of good standing.

EXPERIENCE.—Must have had experience with maintenance and operation of large E.H.T. switchgear, transformers, relays and protective systems. Previous experience in control work very desirable.

The commencing salary will be Tls. 450 per month (ultimately rising to Tls. 630 per month.).

(B) ASSISTANT SHIFT CHARGE ENGINEERS.—The duties attaching to these appointments are those connected with the operation of shifts in a large modern power station.

Applications will only be considered from those having the following qualifications :—

AGE.—Not to exceed 30 years, and preferably single.

TECHNICAL EDUCATION AND ATTAINMENTS.—A knowledge of electrical and mechanical engineering such as will enable the candidates to pass the I.E.E. examination for election as Associate Members.

PRACTICAL ENGINEERING TRAINING.—Preferably mechanical and electrical ; alternatively, mechanical only, in the works of a well-known engineering firm.

EXPERIENCE SUBSEQUENT TO TRAINING.—Preferably as Junior or Assistant Shift Engineers in large modern power stations, and having served in this capacity as immediate Juniors to Charge Engineers in the control and scientific operation of power station plant from boiler-room to control room. A knowledge of pulverised fuel working will be regarded as an advantage, but is not essential.

The commencing salary will be Tls. 350 per month, rising to Tls. 400 in three years, ultimately rising to a maximum of Tls. 580 per month.

GENERAL.—Each appointee will be provided with free medical attention and will participate in the Council's Superannuation Fund and other benefits, which will be explained to candidates.

The present value of the Tael is approximately 2s. 4d.

The first engagement will in each case be for a period of three years, and free second-class passage out and home will be provided.

The maximum system load at present is 100,000 kW, the annual output is 530 million units, and the generating plant capacity is 161,000 kW.

Applications should be submitted in writing only, giving full particulars as to age, education, training, subsequent experience and present position held, together with copies of testimonials, and forwarded to C. S. Taylor, M.Inst.E., M.I.E.E., Deputy Engineer-in-Chief and Manager, c/o Messrs. Preece, Cardew, and Rider, 8, Queen Anne's-gate, London, S.W. 1, not later than Friday, the 15th March, 1929.

Envelopes should be marked with the letter "A" or "B" corresponding to the appointment applied for.

H. "T." ALDRIDGE,
M.I.E.E., M.I. Mech. E., Fel. A.I.E.E.,
Engineer-in-Chief and Manager.

7th March, 1929. 1185

Wanted, a Thoroughly Competent and experienced MECHANIC, to

Take Charge of and Keep in Repair the Mechanical Plant at this Gasworks. Must possess thorough knowledge of High-speed and Reciprocating Steam Engines and Turbines, Dynamos, Motors, and Electrical Equipment.

Applications, stating age and wages required, to be sent, with copies of testimonials, to

J. W. AUCHTERLONIE,
Engineer and Manager,
Cambridge University and Town Gas Light Company,
Cambridge. 1148

YARROW HOME and HOSPITAL
FOR CHILDREN
BROADSTAIRS.

For the Early & Preventive Treatment of Disease & Convalescence after Illness.

The Hospital is intended for the children of Members of the Institution of Civil Engineers, the children of architects, artists, authors, clergymen, members of the medical, legal, and other professions, members of scientific societies, officers of the Navy, Army, and Royal Air Force, officers of the Merchant Navy, schoolmasters and university professors.

Accommodation is provided for 50 Boys between the ages of 4 and 12 years, and 50 Girls between the ages of 4 and 14 years. In special cases the age limits may be raised to 14 for Boys, and 16 for Girls.

Fee 21/- per week, or as may be arranged, and travelling expenses.

Particulars can be obtained from the Secretary :—

116, Victoria Street, Westminster, LONDON, S. W. 1.

PUBLIC NOTICES

Edinburgh Corporation Electricity Supply.

The Lord Provost, Magistrates and Council of the City of Edinburgh have FOR DISPOSAL THIRTEEN MARINE TYPE BOILERS, lying at Dewar-place Generating Station, suitable for 150 lb. working steam pressure. The boilers are 12ft. long by 10ft. 3in. diameter, and have two furnaces fitted with auto. stokers and capable of evaporating 6000 lb. of water per hour.

An opportunity will be given to intending purchasers to inspect the plant and obtain further particulars. The Corporation do not bind themselves to accept the highest or any Tender.

Offers for this plant must be sent to the Engineer and Manager, Electricity Department, Dewar-place, Edinburgh, not later than first post on Monday morning, March 18th, 1929.

A. GRIERSON, S.S.C.,
Town Clerk.

City Chambers, Edinburgh.
6th March, 1929. 1180

Singapore Improvement Trust.

SINGAPORE, STRAITS SETTLEMENTS.
TOWN PLANNING ASSISTANT.

The Singapore Improvement Trust REQUIRES a TOWN PLANNING ASSISTANT for its permanent staff, the appointment being in the first instance on a three years' agreement.

Candidates should be 23-27 years of age and unmarried.

Candidates must have had a good general education. They must have received technical training in civil engineering and preferably have passed the Associate Membership Examination of the Institution of Civil Engineers.

Candidates must be prepared, if required, to take up a course of instruction in Town Planning and to sit for the Associate Membership Examination of the Town Planning Institute. Previous experience on town planning or housing projects will be an advantage.

Strict medical examination.

Salary 5280 dollars, 5760 dollars and 6240 dollars per annum respectively for the three years of the agreement and rising thereafter if service be continued. Transport allowance 1284 dollars per annum. The exchange value of the dollar is 2s. 4d. sterling, at which rate the salary for the first year would amount to £616. There is at present no income tax.

Free first-class passage will be provided, with half salary during the voyage out and a return passage on satisfactory completion of the agreement (if not renewed), provided that the officer returns to England forthwith.

Eight months' leave, with full pay, is normally granted after four years' service. Liberal Provident Fund.

Applications, stating whether married or single and giving age and birthplace, with details of education, training and experience, and referring particularly to the qualifications mentioned above, and accompanied by copies (not originals) of testimonials, to be lodged with Messrs. PEIRCE and WILLIAMS, MM. Inst. C.E., 64, Victoria-street, London, S.W.1, Agents to the Trust, not later than Friday, 15th March, 1929.

Further particulars, if desired, can be obtained from the Agents. 1123

SUB-AGENT.

Sir John Jackson, Limited,

are prepared to consider APPLICATIONS for the POST of SUB-AGENT for the Construction of Singapore Naval Base.

Applications will be treated in strict confidence, must be in writing, and only those who have held a similar position on large contracts will be considered.

Full particulars as to age, experience, and salary required must be given.

The engagement will be for a period of approximately 7 years.

Applications to have letters "S.A." on envelope and addressed MANAGING DIRECTOR, Sir John Jackson, Limited, 53, Victoria-street, S.W. 1. 1178

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, ASSISTANT LONDON REPRESENTATIVE to Firm of Constructional Engineers. Should have good presence and connection among architects and builders. Public school education preferred.—Write, Box 1537, c/o A. B. Brown, 39, Tothill-street, S.W. 1. 1172 A

WANTED, ASSISTANT OILFIELDS STOREKEEPER for service in Iraq. Must be unmarried and not over 32 years of age and have had several years' experience of Engineering Materials, Storekeeping Organisation ; actual oilfields' experience preferred. Salary according to qualifications.—Apply by letter, giving full particulars, to "STAFF," Turkish Petroleum Company, Ltd., 97, Gresham-street, London, E.C. 2. 1168 A

WANTED, BLAST-FURNACE MANAGER, to Take Control of Blast-furnace Plant for the production of High-grade Foundry Iron. Must be fully conversant with modern methods of manufacture and grading. Excellent opportunity for energetic man anxious to improve position. State age, experience, and salary required.—Address, 1209, The Engineer Office. 1209 A

WANTED, COMPETENT RATE FIXER for Machine Shop ; only men conversant with Machining Steel Castings to fine limits for the Commercial Vehicle Industry and experienced regarding cutting feeds and speeds need apply.—Address, giving full particulars of experience, age, and remuneration required, 1052, The Engineer Office. 1052 A

WANTED for an English Firm of Metal Merchants and Engineers in Calcutta, a TRAVELLING REPRESENTATIVE. Five years' agreement ; must be unmarried, age 23 to 27 ; commencing salary Rs. 500 per month.—Write, with copies of testimonials and photograph if possible, to Z.D. 637, c.o. Deacon's, Fenchurch-avenue, E.C. 3. 1221 A

WANTED for Oilfield in the Tropics, ASSISTANT to CHIEF ENGINEER ; age 30-35 ; primarily a Mechanical Engineer with Civil and Electrical Engineering Experience, with University Degree. Preference given to men with experience in Oilfield Work or in Erection of large Power Plants, in Mines, Factories, &c., and capable of Preparing Estimates and Lay-out Drawings. Five-year contract ; free passage out and home.—Full details on application to Z.B. 635, Deacon's Advertising Agency, Fenchurch-avenue, London, E.C. 3. 1222 A

SITUATIONS OPEN (continued)

WANTED for Oilfields in Burma, Young ENGINEER, with Electrical Training ; 3 years' engagement, passage paid out and home. Age about 25 years. Salary according to qualifications, but not less than £400 per annum.—Write, "S.O.," c/o Street's, 6, Gracechurch-street, E.C. 3. 1160 A

WANTED, Young ENGINEER, with Public School education, to undergo works training with a view to acting as Technical Assistant to Agent in India. Good prospects for suitable man.—DAVID BROWN and SONS (HUDDFD.), Ltd., Park Works, Huddersfield. 1165 A

A GOOD OPENING OCCURS for a Competent ESTIMATOR experienced in Mechanical Handling Plants. State experience, age, and salary.—Address, 1215, The Engineer Office. 1215 A

BOILERMAKER REQUIRED for Oilfields in Mesopotamia. Qualifications : good general all-round Boiler Repair Shop training and experience. Able to turn to all sorts of plating work in addition to repairs. Salary according to qualifications.—Will applicants please apply in writing, with full particulars, to TURKISH PETROLEUM COMPANY, Ltd., 97, Gresham-street, London, E.C. 2. 1160 A

CONSULTING CIVIL ENGINEER in Westminster REQUIRES ENGINEERING ASSISTANT, with good general experience ; knowledge of Reinforced Concrete essential, and must be good Draughtsman and Surveyor. Salary according to qualifications, not exceeding £260 p.a.—Address applications, stating age, experience and salary required, with copies of two recent testimonials and particulars of engineering qualifications, &c., to 1225, The Engineer Office. 1225 A

CHIEF ENGINEER REQUIRED by a Provincial Omnibus Company operating over 300 omnibuses covering a wide area, from a number of depots. Applicants must be fully experienced in the latest works methods and the operation of omnibuses. Commencing salary £750 per annum. Only those who can show such qualifications need apply. Preference will be given to those who have held a similar position. State age, whether married, and particulars of experience and qualifications.—Address, 1200, The Engineer Office. 1200 A

CONSTRUCTIONAL DEPARTMENT. — Energetic LEADING HAND, with sound theoretical knowledge and practical experience in all classes of Constructional Work.—Apply, stating age, qualifications, and salary required, to MANAGER, Constructional Department, Frodingham Iron and Steel Co., Ltd., Scunthorpe, Lincs. 1171 A

ENGINEER and GENERAL MANAGER REQUIRED IMMEDIATELY by small but growing Welding Company in Provinces. Must be expert on all branches welding and have commercial and general engineering experience. Successful results would be fully recognised in terms offered, and proved man would be permitted to take financial interest if desired.

Address, P5614, The Engineer Office. P5614 A

ENGINEER REPRESENTATIVE.—An OPENING OCCURS in the London Branch of British Manufacturing Engineers. State in confidence full particulars of training and subsequent experience, with salary expected.—Address, 1198, The Engineer Office. 1198 A

ENGINEER REQUIRED for Maintenance of Plant and Machinery in Boiler Shop, manufacturing electrically welded vessels. Must be thoroughly experienced in repairs, electrical and mechanical. Will have charge of small maintenance staff. Permanency for suitable man. State age, experience, when at liberty, and salary required.—ROBERT JENKINS and CO., Ltd., Rotherham. 1205 A

EXPERIENCED CRANE DESIGNER WANTED, accustomed to making designs and estimates of Steam and Electric Cranes of all types.—Apply, giving full particulars of training, experience, age, and salary required, to Messrs. COWANS, SHELDON and CO., Limited, Carlisle. 1226 A

LAYER-OUT WANTED for CANADA

The Toronto Iron Works Limited, Toronto, Ontario, Canada, a Canadian Company manufacturing Steel Tanks—Bins—Hoppers—and a general line of Steel Plate work, REQUIRES A FIRST-CLASS LAYER-OUT. Must be able to work from outline drawings. Applicants must give full information regarding age, education, nature of work on which they have been employed. Wages for competent man 65 cents per hour—50 hour week. Yearly contract and steady employment guaranteed. Make preliminary application by letter to Mr. A. V. BOWATER, Consolidated Press Ltd., 10, Norfolk Street, Strand, London, W.C. 2. 1239 A

MACHINE SHOP PRODUCTION ENGINEER REQUIRED to Take Charge of Small Machine Shop employing about 20 hands on varied and miscellaneous work. Permanency for suitable man. State age, experience, and salary required.—ROBERT JENKINS and CO., Ltd., Rotherham. 1204 A

RATE FIXER REQUIRED for Engineering Factory in London. Must be fully experienced in all branches of rate fixing and layouts.—Address, stating age, experience, and salary required, 1212, The Engineer Office. 1212 A

REINFORCED CONCRETE SENIOR DESIGNER REQUIRED with specialist experience in all types of Reinforced Concrete Construction.—Applications by letter, giving in confidence a brief summary of qualifications, experience, age, and salary required, to the SECRETARY, The British Reinforced Concrete Engineering Co., Ltd., Stafford. 1177 A

SUPERVISING ENGINEER.—THE CLYDE ALLOY STEEL CO., Ltd., Motherwell, desire to THANK APPLICANTS for the situation advertised recently and to state that the APPOINTMENT has now been MADE. 1181 A

SITUATIONS OPEN (continued)

THE BRITISH REINFORCED CONCRETE ENGINEERING COMPANY, Ltd., REQUIRE the SERVICES of TWO JUNIOR REPRESENTATIVES with a knowledge of Reinforced Concrete Construction or Structural Engineering. Previous travelling experience not essential, but applicants must be of good appearance and address, and have an aptitude for the commercial side of business.

Replies, stating age, qualifications, and salary required, should be marked "Junior Representatives" and addressed to Lichfield-road, Stafford. 1184 A

TWO JUNIOR OUTSIDE ENGINEERS REQUIRED, with up-to-date practical and theoretical experience. Their work would deal with erection of new and alterations and maintenance of existing plant. Age 26-30.—Address, giving full particulars of qualifications and salary expected, 1190, The Engineer Office. 1190 A

WELDING, ELECTRICAL AND GAS.—Young ENGINEER, with good training and experience, WANTED to Take Complete Charge of Welding Department for production of fabricated and other welded work.—Address, 1158, The Engineer Office. 1158 A

WANTED, DRAUGHTSMAN, with Good Knowledge of Tank and Light Boiler Work. Permanent job for suitable man.—Address, with particulars of experience, references, and when available, 1235, The Engineer Office. 1235 A

WANTED, for Three Years' Service in India, First-class DETAILING DRAUGHTSMAN, used to Structural Work and Bridges. Salary 650 rupees per month.—Apply, stating age and experience, together with copies of recent references, BRAITHWAITE and CO., ENGINEERS, Ltd., West Bromwich. 1189 A

WANTED, Heavy Machine Tool DRAUGHTSMAN, Manchester District ; state age and experience.—Address, P5607, The Engineer Office. P5607 A

WANTED in London, DRAUGHTSMAN, Gear-boxes, good calculations. State age, salary, experience in detail, with names.—Address, P5589, The Engineer Office. P5589 A

WANTED, MECHANICAL DRAUGHTSMAN for a few months, London City. Possibly spare time might be arranged. State experience, qualifications, and salary required.—Address, 1214, The Engineer Office. 1214 A

CAPABLE DRAUGHTSMAN REQUIRED, Experienced in Shovels and Cranes.—Write, giving full particulars as to experience, qualifications, age, and salary, to Box 935, T. B. Browne's Advertising Offices, 163, Queen Victoria-street, London, E.C. 4. 1201 A

DRAUGHTSMAN, Experienced in Structural Steel Work and General Mechanical Engineering, knowledge of Reinforced Concrete Work an advantage. State age, experience, and salary required.—Address, 1227, The Engineer Office. 1227 A

DRAUGHTSMAN REQUIRED for Westminster office, with experience in Cranes.—Address, stating experience, age, and salary required, 1231, The Engineer Office. 1231 A

DRAUGHTSMAN REQUIRED for Westminster office, with Structural and Mechanical experience, used to Conveying Plants. State age, experience, and salary required.—Address, 1232, The Engineer Office. 1232 A

DRAUGHTSMAN, with Experience of Power Transformers.—Apply, stating age, experience, and salary required, to MANAGER, Drawing Offices, B.T.H. Co., Ltd., Rugby. 1229 A

DRAUGHTSMAN DESIGNER, Experienced, for Commercial Vehicle and Bus Chassis Layout and Design of Components, Permanency, near London. Age, experience, and salary.—Address, 1233, The Engineer Office. 1233 A

DRAUGHTSMAN for Heavy Oil Engines, Land Type.—Address full particulars, age, and salary required, 858, The Engineer Office. 858 A

DRAUGHTSMAN (Not Junior) for Pumping Machinery, Reciprocating and/or Centrifugal.—Address, stating age, experience, salary required, 857, The Engineer Office. 857 A

DRAUGHTSMAN REQUIRED by Firm of General Engineers and Road Vehicle Manufacturers in the Midlands.—Address, stating age, experience, and salary required, 1220, The Engineer Office. 1220 A

DRAUGHTSMEN REQUIRED for Aircraft Design Work, used to design of light fittings or sheet metal construction ; aircraft experience not essential. Good opportunity for quick reliable men with requisite technical capabilities.—Apply by letter, stating age, experience, and salary required, to HANDLEY PAGE, Ltd., Cricklewood, N.W. 2. 1186 A

DRAUGHTSMAN.—REQUIRED, in London Office of Firm of Engineers, DRAUGHTSMAN with knowledge of Conveying and Mechanical Handling Plants. Experienced men only need apply. State age, experience, and salary required.—Address, 1073, The Engineer Office. 1073 A

DRAUGHTSMAN, with Sound Knowledge and general experience of Factory Plant and Layout of all service (excluding electrical), REQUIRED by large manufacturing concern in the London area, having its own maintenance staff employed in the various trades.

Write, giving experience, training, age, and salary required, to Box E. 978, c/o C. Mitchell and Co., 1, Snow-hill, E.C. 1. 1156 A

FIRST-CLASS DRAUGHTSMAN REQUIRED, Capable of designing and developing small Mechanical and Electrical Apparatus. Applicants must possess originality, be fully conversant with up-to-date production methods and be able to fix limits on dimensions. Knowledge of jig and tool work an advantage. Good prospects for right man.—Write, giving particulars of experience, age, and salary required, to THE PLESSEY CO., Ltd., Vicarage-lane, Ilford. 1208 A

FIRST-CLASS MECHANICAL DRAUGHTSMEN WANTED AT ONCE, with thorough knowledge of Overhead Electric Travelling Crane Practice. State experience, age, technical qualifications, and salary required.—Address, 1157, The Engineer Office. 1157 A

JIG and TOOL DRAUGHTSMEN REQUIRED for a Motor Car Firm in Coventry.—Address, stating age, experience, and salary required, 1175, The Engineer Office. 1175 A

JUNIOR MECHANICAL DRAUGHTSMAN for London district. Works and D.O. experience desirable, with some knowledge Light Structural Steel and Bunker Work.—Address, P5616, The Engineer Office. P5616 A

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., Trafford Park, Manchester, REQUIRES a DESIGNING DRAUGHTSMAN for switchgear. Must be neat, quick and accurate and have had experience in the designing of switchgear for all voltages. State training, experience, and salary required. —Apply by letter, addressed to the COMPANY'S EMPLOYMENT DEPARTMENT, marked "Switchgear Draughtsman." 1159 A

REQUIRED, a First-class DRAUGHTSMAN for Experimental Drawings. Applicants must have experience in Automatic Machines and Mechanical Devices in general.—Write, giving full particulars of experience, age, and salary required, to Box M. 649, Willing's, 125, Moorgate, E.C. 2. P5586 A

REQUIRED, JUNIOR DRAUGHTSMAN for London. Applicants should apply by letter, giving particulars as to age, qualifications, and salary required.—Address, 1216, The Engineer Office. 1216 A

SEVERAL Good MECHANICAL DRAUGHTSMEN REQUIRED in County Durham, having thorough experience in Materials Handling Equipment, especially as applied to Power Stations, Gasworks and Quarries. State fully past experience, salary expected, and when at liberty.—Address, 1228, The Engineer Office. 1228 A

For continuation of Small Advertisements see page 4.

A Seven-Day Journal

The New Year Honours.

THE list of New Year Honours, the publication of which was delayed on account of the King's illness, was issued on Thursday evening of last week. Among the names included in the list is that of Mr. W. R. Morris, of Morris Commercial Cars, Ltd., and Morris Motors (1926), Ltd., on whom a baronetcy has been conferred. Dr. J. A. Fleming, Emeritus Professor of Electrical Engineering, University College, London, and Mr. A. V. Roe, a pioneer of the aeronautical industry, and Colonel T. F. Purves, Engineer-in-Chief to the Post Office, have received the honour of knighthood, as has Mr. John Jackson, deputy chief inspector of factories, Home Office. A Companionship of the Bath has been awarded to Engineer Rear-Admiral H. F. Smith and to Mr. L. H. Saville, Civil Engineer-in-Chief, Admiralty. Lieut.-Colonel J. F. H. Carmichael, one of the Crown Agents for the Colonies and Engineer-in-Chief, has received a Knight Bachelorship. A similar honour has been conferred on Mr. G. A. Julius, chairman of the Australian Council for Scientific and Industrial Research. Among those appointed to the Order of the British Empire are Sir W. S. McCormick, chairman of the Advisory Council of the Department of Scientific and Industrial Research, who has received the G.B.E.; and Mr. G. E. Suter, constructive manager, Portsmouth Dockyard, who has been awarded the C.B.E.

The Air Estimates.

THE Air Estimates, issued last Saturday, show a reduction of £50,000, namely, from £16,250,000 a year ago, to £16,200,000. The programme of development outlined for the Royal Air Force during the coming year covers an increase of our air defences by the equivalent of seven new squadrons, of which three will be Auxiliary Air Force Squadrons for home defence. All the auxiliary squadrons, it is gathered, are to be re-equipped with Westland "Wapiti" machines. A sum of £16,000 is included for subsidies to thirteen light aeroplane clubs and £3000 is set aside for grants to the new company, National Flying Services, Ltd. The subsidies payable to Imperial Airways, Ltd., are estimated at £349,000, as compared with £230,000 last year, the increase being largely accounted for by the fact that next month a weekly air service to India will be established by the company. Provision is made in the Estimates for preliminary work connected with the establishment of an Imperial air service to South Africa.

Pulverised Fuel for Cargo Ships.

IN last week's Journal we referred to the progress made in the application of pulverised fuel to cargo ships, and gave particulars of the "Brand," "Howden-Buell," and "Woodeson" installations, some of which are in service and others are about to be begun. According to news from America, it has been decided by the United States Shipping Board to convert the cargo steamer "West Alsek" for burning pulverised fuel on the Todd system. The contract has been awarded to the Todd Shipyards Corporation, of New York, and the vessel is now at the firm's Brooklyn yard, where the work is being carried out. It is expected that official trials will be run during the latter part of May. The "West Alsek" is a 410ft. steamer, with a beam of 54ft., and is propelled by a 2750 I.H.P. triple-expansion engine, steam being provided by three single-ended hand-fired Scotch boilers. The Todd system, which has been successfully tested by the Philadelphia Naval Department, differs from other schemes in that a separate motor-driven pulveriser is used for each furnace and forms a part of the burner equipment. The small pulverisers are fitted quite close to the furnace front, and the coal is delivered to the burners by the primary air blower, after being ground by the pulverisers to such a degree of fineness that it will pass through a 300-mesh screen. A feature of the official tests referred to was, we are informed, the success of the system when using fuels containing up to 10 per cent. of moisture.

New British Built Liners for Sweden.

THERE was recently launched from the Wallsend yard of Swan, Hunter and Wigham Richardson, Ltd., the passenger liner "Britannia," which, together with the sister steamer the "Suecia," launched about a month ago, is being constructed for the London–Stockholm service of the Swedish Lloyd Steamship Company. The new ships, which are to be delivered in May, will be the largest and fastest steamers in the North Sea service, and will enable travellers to complete the journey between the Thames and Sweden between Saturday evening and Monday morning. They each have a length of 376ft. overall, with a beam of 50ft. and a deadweight carrying capacity of about 2230 tons. Passenger accommodation is to be provided for 200 first-class and 40 third-class passengers. The public rooms of one of the ships, the "Britannia," will be designed and fitted out in British style, while the "Suecia" will be decorated and furnished in accordance with Swedish ideas. The hulls will be specially strengthened for navigation in ice, and the five cargo holds will have a total bale cargo capacity of about 142,000ft., which will include 6300 cubic feet of refrigerated space. The safety and navigation equipment will be of the latest type. Single-screw propelling machinery of the Parsons single-reduction geared turbine type is to be installed, and the arrangement will comprise three turbines each driving a separate pinion gearing with the main wheel on the propeller shaft. Steam will be raised in four single-ended coal-fired multitubular type marine boilers, fitted with superheaters, and the boilers will be worked under the Howden system of forced draught. For electric light and power there will be two 32-kW steam-driven generator sets, and one 15-kW emergency lighting set.

Electricity in Rural Areas.

THE development of electricity supplies in rural areas is a matter which the Conservative Agricultural Committee has had under consideration for a considerable time, and at the weekly meeting of the Committee held some few days ago, Lieutenant-Colonel Ashley, the Minister of Transport, and Sir John Snell, the Chief Electricity Commissioners, were present to answer questions on the subject. Lieutenant-Colonel Ashley stated that contracts representing £3,000,000 had already been placed for the erection of the transmission lines, and that steps were about to be taken for the electrification of a typical rural area, which he hoped would make electricity available to all classes, including the cottagers. The scheme would include assisted wiring and a plan of hiring and hire purchase, making current available for electric light, heat and power. Special consideration was being given to the appointment of an official who would devote the whole of his time to the development of electricity in rural areas. Sir John Snell answered many technical questions, and announced that owing to the removal of restrictions and the revision of regulations, it was now possible to construct low-tension overhead lines at under £200 per mile. He also urged the need for co-operation on the part of all landowners, local authorities and others connected with the granting of wayleaves. On the proposal of Mr. Hurd, a resolution was passed informing the Postmaster-General of the interests and appreciation of the Committee in the new policy for the development of rural telephones, and urging that the proposals should be executed as speedily as possible. It was pointed out that this development would, by taking the form of a system of voluntary automatic village exhanges, overcome two of the main difficulties met with in the past—the lack of secrecy and the limit of the hours of service.

Television.

ON Tuesday the Postmaster-General was present at a demonstration of the Baird television system, but up to the time of writing no statement has been made concerning the results achieved. There are many aspects which the Postmaster will have to consider, and some considerable time is likely to elapse before any opinion is expressed. A test was also made on Monday when a number of Post Office and B.B.C engineers attended and saw transmissions from 2 LO to the General Post Office. It will be remembered that some months ago the B.B.C. engineers were present at a test of the Baird system of television, and afterwards stated that in their opinion it was not sufficiently advanced to warrant them granting the use of any of the B..B.C. stations for experiments. The statement added, however, that the engineers would be prepared to reconsider the matter as soon as improvements were made. Replying to a question in the House of Commons on the subject, the Postmaster-General said that Tuesday's demonstration was witnessed by a few members of Parliament of all parties, in addition to representatives of the B.B.C and the Baird company. It was necessary to restrict the number present to a minimum, because the apparatus made it impossible for more than a few persons to witness the experiment simultaneously. Mr. Thurtle asked whether the Postmaster-General would bear in mind that great speculation was going on in the Stock Exchange regarding the Baird Company, and said he hoped that the Post Office would not lend itself to any such market operations. Sir W. Mitchell-Thomson replied that there were a great many factors to be considered before he could make any recommendation. The demonstration took place on the understanding that on no side should any information be given to the Press.

British Railways and Aviation.

ON Tuesday a special general meeting of the London, Midland and Scottish Railway Company was held at Euston in order to submit for the approval of the shareholders certain Bills and Orders which the company is promoting in Parliament. Principal interest attached to the company's Air Transport Bill. Bills of a similar form are being promoted by the other amalgamated companies. The main provision of the L.M.S Bill will empower the company to provide and use aircraft for the conveyance of passengers and merchandise to or from aerodromes situated in the United Kingdom in districts to which access is afforded by the company's railway system. The Bill will also empower the company to provide aerodromes, hangars, garages, and similar accommodation, to enter into working agreements with any other company providing air transport services and to provide funds for such a company, to invest in its securities or to guarantee its dividends. A provisional order authorising the company to provide air transport services in Scotland is also being promoted. Resolutions approving the Bills and Orders were unanimously adopted.

An American Award to a British Engineer.

THE American Institute of Electrical Engineers has awarded the first—1928—Lamme Medal to Mr. Allan Bertram Field, "for the mathematical and experimental investigation of eddy current losses in large slot wound conductors in electrical machinery." The Lamme Medal was founded as a result of a bequest in the will of the late Benjamin G. Lamme, chief engineer of the Westinghouse Electric and Manufacturing Company, to provide for the award by the Institute of a gold medal annually to one of its members "who has shown meritorious achievement in the development of electrical apparatus or machinery." Mr. Field is the consulting engineer to the Metropolitan Vickers Electrical Company, Ltd., Manchester, and was born in New Barnet, Hertfordshire, in 1875. After receiving his early education in London, he attended the Finsbury Technical College. Following studies at St. John's College, Cambridge, from 1896 to 1899, and the passing of the Mathematical Tripos examination, he was awarded the Honours B.A. degree. He was later awarded the M.A. degree in the regular course. He took the Honours Science examination of the University of London, and received the Honours B.Sc. degree in 1900. From 1899 to 1902 he was engaged in engineering work in traction, power, and lighting projects with the British Thomson-Houston Company in London. In order to become more familiar with American practice, he joined the General Electric Company in 1902. From 1905 to 1908 he was employed with the Bullock Electric Manufacturing Company and the Allis-Chalmers Company in the design of generators and motors. He joined the engineering staff of the Westinghouse Electric and Manufacturing Company in 1909, and in 1911 was appointed engineer-in-charge of turbo-generator design. During the next two years he was responsible for the development and commercial introduction of the built-up rotor design, and solved, in collaboration with Mr. Lamme, many problems of turbo-generator design. He was consulting engineer and Professor of Mechanical Engineering at the University of Manchester from 1914–1917, and during the next three years was with Vickers Ltd., in London. Since 1920 he has been consulting engineer to the Metropolitan-Vickers Electrical Company, Ltd., Manchester. In 1918 he was temporarily appointed by the Admiralty as first technical director of the Admiralty Experiment Station—anti-submarine—Shandon, Scotland.

The Channel Tunnel.

AT a lecture given last week in London, Baron Emile d'Erlanger, chairman of the Channel Tunnel Company, dealt with the history of the Tunnel and some of the commercial and engineering problems involved in its construction. The pilot tunnel, he said, would be between 8ft. and 12ft. in diameter, and would take about 2½ years to make. The twin traffic tunnels would each be about 18ft. in diameter, and would require about 4½ years to construct. With its approaches, the Tunnel as a whole would have a length of about 33 miles. The capital cost was estimated at 30 million pounds, namely, 25 millions for the traffic tunnels and 5 millions for the pilot tunnel. He believed it was safe to take it that when the Tunnel was opened, four million passengers at least would use it per year. Taking the fare at 16s., the average fare to-day for the cross-Channel steamer service, he anticipated a revenue of £3,200,000 from the passenger traffic. The transport of merchandise, &c., might be expected to bring in something more than £800,000. The cost of working the Tunnel might be taken at 25 per cent. of the gross receipts. The working expenses would therefore absorb £1,000,000, leaving £3,000,000 for the capital of 30 million. He held that the strata underneath the Channel being chalk, would render the boring of the Tunnel easy. From the engineering point of view, it was very improbable that there would be any great difficulties to overcome. He thought that the Tunnel should be owned by two companies, one British and one French, with directors approved by the British and French Governments respectively, and that the securities of the two companies should be thrown into a holding company, which for preference might be registered under the League of Nations.

The London Power Company.

No. IV.*

THE GROVE-ROAD STATION (*Continued*).

WE have said enough to show that the thermal efficiency claimed for Grove-road may be accepted with no hesitation whatever, for there is no room for any appreciable error to occur in either the weight of coal burnt during any reasonable period, nor in the power turned out. As to the temperature readings, upon which the apportionment of the efficiency of the various items of plant so greatly depends, we may say that something like 50,000 temperature records were taken in the boiler-house alone during 1927. Each boiler is provided with a complete distance reading thermometer outfit of the Cambridge Instrument Company's make. To ensure accuracy, in all cases where the flow of air or gas may be stratified, the temperature is taken at more than one point and the results averaged. The temperature of the flue gases leaving each boiler is thus measured at three points across the uptake. The outlet gases from the economiser and air heater are likewise measured at three points in each duct. The heated air entering the grates is measured at two points; while one point only is sufficient in each case for the temperature measurements of the feed entering the economiser, the feed entering the boiler, the air entering the air heater, and the steam leaving the superheater. Thus in connection with each boiler there are no less than fifteen temperature-measuring points, giving between them eight separate temperatures. Flue gas temperature measurements serve as a useful operating guide for the boiler attendants. There is kept in the boiler-house a graphical record of the final gas temperature of each boiler at the time of peak load. Should the temperature curve rise, more use is made of the soot blowers. A temperature of 400 deg. Fah. at the economiser outlet, with 12 per cent. of CO_2 and full load on the boiler, is considered the limit. Should it be reached in spite of the soot blowers, the boiler is laid off for a thorough external cleaning. Without soot blowing at all the limiting temperature would be reached after about 300 hours' steaming, the boiler efficiency falling off steadily all the time. The boiler then is in such a state that no further dust can find place for lodgment. The efficiency therefore remains constant, except in so far as it is affected by further deposits of scale in the tubes. The average temperature of the gases leaving the economisers at Grove-road is 366 deg. Fah., and that of the gases at their final exit is no higher than 219 deg. Fah. for the six largest boilers. Scale affects the results very slightly, as there is very little deposit in the tubes Indeed, the only scaling the boilers need is scraping the two or three rows next to the fire with a mechanical tube cleaner once a year, when the boilers are down for their annual examination and overhaul.

FIG. 11—GROVE-ROAD POWER-HOUSE—FIRING AISLE

Fig. 11 is a view of the firing aisle of the western boiler-house, showing the six boilers of 75,000 lb. capacity. Particulars of these boilers have been given already in Table VI. There are three boilers on each side of the house, each set of three being served by two chimneys with four fans for induced draught and three for forced draught. The air and flue gas ducts can be made common to all boilers on each side, but experience shows that the advantages of such an arrangement are questionable. The stokers are fed by shoots, having a continual reciprocating motion from side to side of the hoppers, so as to distribute the coal evenly and to avoid the segregation of large and small sizes which is found to occur with plain shoots. Above each stoker is an automatic Avery coal weigher to record the fuel consumed. The thoroughness of the instrument equipment will be evident from Figs. 12 and 13. The former illustration shows the instrument panel for boilers Nos. 27 and 28, containing no less than twelve indicating gauges of one sort or another for each boiler. Below the panel are the "Mono" recorders, which show the percentages of both CO_2 and of combustible gases in the flue gases. Fig. 13 is a view taken in the boiler control room. By means of the instruments shown, the temperature of flue gas, water, steam or air at all essential points of every boiler unit can be instantly observed or continuously recorded. The operation of each boiler is therefore under constant and minute supervision, so that any departure from the best conditions of working is immediately brought to notice.

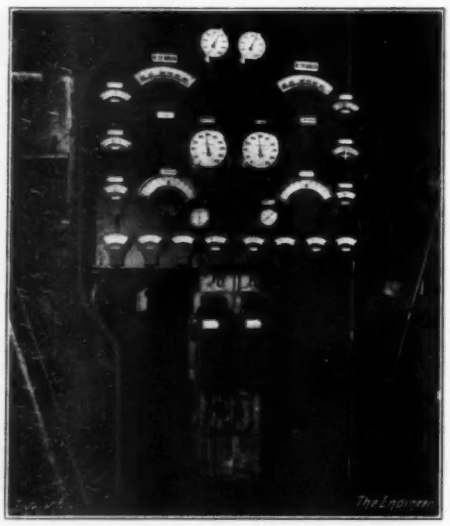


FIG. 12—INSTRUMENT PANEL FOR TWO BOILERS

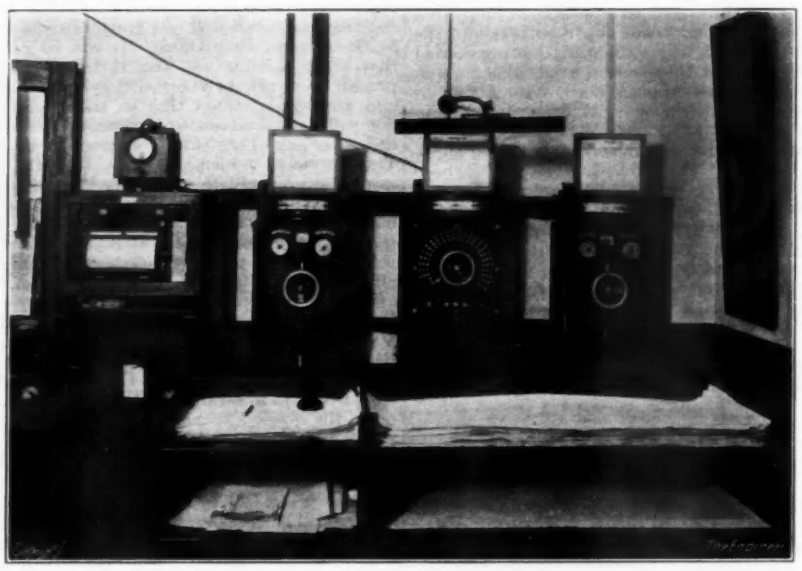


FIG. 13—BOILER CONTROL ROOM

Since the boilers in this boiler-house are particularly efficient modern units, and have been tested with a thoroughness typical of the Grove-road station, we will give their performances in some detail. We are all the more pleased to do this because reliable boiler tests, containing all the data necessary for the results to be valuable, are far too rare, and when they are carried out the parties concerned do not always show the broadmindedness of the London Power Company in consenting to publication for the benefit of engineers in general.

The boilers selected for thorough test were Nos. 26, 27, 29, and 30. The boilers, superheaters, economisers, and air heaters of all the units were of the same size and construction, the leading dimensions being as in Table VI. (*ante*). The only differences were in respect of the grates and furnace arches, details of which are as follows:—

No. 26 boiler—
Two B. & W. compartment stokers; grate area, 360 sq. ft.
Two sprung arches.

No. 27 boiler—
Two type "A" stokers of the Underfeed Stoker Company; grate area, 340 sq. ft.; one Detrick suspended roof.

No. 29 boiler—
Two B. & W. compartment stokers; grate area, 360 sq. ft.
One Liptak suspended roof.

No. 30 boiler—
Two type "A" stokers of the Underfeed Stoker Company; grate area, 352 sq. ft.; one Detrick suspended roof.

The trials covered both normal and overload conditions. The normal load trials were of eight hours' duration, while the overload trials were continued for two hours only, as the object of the latter was merely to see whether the overload could be obtained quickly and carried without overheating of the grates or the emission of black smoke. Every possible precaution was taken to ensure the accuracy of the figures obtained, and all tests were witnessed by engineers

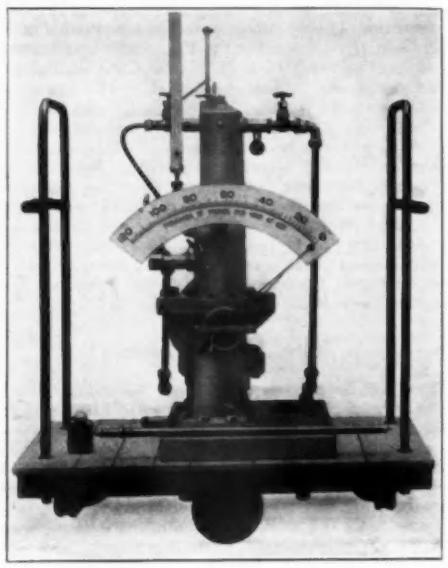


FIG. 14—FEED-WATER FLOW INDICATOR

* No. III. appeared March 1st.

representing Messrs. Kennedy and Donkin, consulting engineers to the Central Electricity Supply Company, Messrs. Babcock and Wilcox, the Underfeed Stoker Company, and Geo. Kent and Co., Ltd.

For the convenience of those readers who may be interested in the final results only, we give a general summary in Table XI.

TABLE XI.—*Summary of Boiler Trials at Grove-road.*

	Normal load trials.					Overload trials.				
Boiler number		26	27	29	30		26	27	29	30
Date of test		29/9/27	4/8/27	21/7/27	12/5/27		28/9/27	8/8/27	20/7/27	19/10/27
	G'r'n'ts					G.r.n.ts				
Evaporation per hour, lb.	73,333	75,857	77,310	73,891	77,638	91,666	100,028	105,900	103,555	100,725
Steam pressure, lb. per sq. in.	210	209	207	201·7	205	210	214 196*	212	212	209 196*
Superheat, deg. Fah.	285	310·5	325	303·4	295	285	346	385	348	347·5
Feed water to economiser, deg. Fah.	180	160	170	174	171	180	162	172	168	164
Higher calorific value of coal as fired, B.Th.U. per lb.	9,500 to 10,500	10,260	10,270	9,900	9,740	9,500 to 10,500	10,230	10,490	10,040	10,150
Net thermal efficiency after deducting power used for auxiliaries, per cent.	85	87·60	86·60	86·80	86·48	—	—	—	—	—
Increase of evaporation above normal on overload, per cent.	—	—	—	—	—	25	36·5	44·5	41·0	37·5
Thermal efficiency computed on lower calorific value, per cent.	—	91·85	90·88	91·20	90·81	—	—	—	—	—

* In the case of the overload trials of boilers Nos. 26 and 30 the steam pressures are given at the superheater outlets as well as in the drums.

It will be seen that not only was the guaranteed efficiency of 85 per cent. at normal load easily surpassed in every instance, but overloads varying up to nearly 45 per cent. were carried without trouble. The efficiencies at normal loads, computed on the lower calorific value of the coal are given for comparative purposes in the last line of the table. Although this basis of computation is now discarded, the figures are instructive as showing that the boilers are capable of giving to the steam from 90·8 to 91·8 per cent. of all the heat in the coal which is available for their use. Little, therefore, is the margin for the improvement in these boilers so far as efficiency is concerned.

The full results of the four tests at normal load are given in Table XII.

Sherwood Pea coal was used on all the trials, the higher calorific values as obtained in the laboratory of the Grove-road station being used for the computations of thermal efficiency. Three analyses were made of the coal used on each of the full load trials, and the mean of these three results taken as giving the quality of the coal in each case. Nine further analyses were made for the overload trials, three for one of the trials, and two each for the others. Messrs. Babcock and Wilcox also made independent analyses of the coal used on the four full-load trials, and as the mean of the calorific values obtained by them differed by less than four parts in a thousand from the mean of the corresponding analyses made by the London Power Company, there can be no doubt whatever that the calorific values given in the table are as accurate as any figures of the nature can be.

The coal used for each trial was taken from an adjacent bunker, loaded into barrows and weighed in 2 cwt. lots on a 5-cwt. Avery portable weighbridge. The weighbridge was overhauled and tested by the makers before the trial, and the balance checked at the start and finish of each trial. The coal was fed into the stoker hoppers by hand, the hoppers being levelled off at the start and the finish of each trial, and also hourly during the trials. The riddlings from the grates were burnt.

TABLE XII.—*Full-load Tests of Boilers at Grove-road Station.*

Boiler No.	26	27	29	30
Date of test	29/9/27	4/8/27	21/7/27	12/5/27
Duration of test, hours	8	8	8	8
Description of fuel	Sherwood peas	Sherwood peas	Sherwood peas	Sherwood peas
Proportion of fuel remaining on 1in. screen, per cent.	Nil	0·4	Nil	Nil
Proportion of fuel remaining on ·75in. screen, per cent.	7·14	8·9	6·25	3·6
Proportion of fuel remaining on ·5in. screen, per cent.	45·98	44·6	44·87	46·0
Proportion of fuel remaining on ·25in. screen, per cent.	15·63	14·3	15·62	20·4
Proportion of fuel passing ·25in. screen, per cent.	31·25	31·8	33·26	30·0
Rate of firing, pounds per hour	10,360	10,629	10,349	10,724
Moisture in coal as fired, per cent.	10·10	11·50	11·50	9·95
Volatile matter as fired, per cent.	27·66	26·75	26·22	26·32
Fixed carbon as fired, per cent.	44·05	45·05	42·87	42·63
Ash as fired, per cent.	18·19	16·70	19·41	21·10
Gross calorific value of fuel as fired, B.Th.U.	10,260	10,270	9,900	9,740
Average thickness of fires, inches	4·25	4·25	5 and 5·25	3 and 3·25
Speed of grates, feet per hour	42	47	41	57·5
Power used to operate stokers, kW	2·52	2·9	3·3	1·76
Weight of ashes and clinker, pounds per hour	1,491	1,498	1,659	1,386
Proportion of ashes and clinker to coal, per cent.	14·4	14·09	16·03	12·92
Calorific value gross of ashes and clinker, B.Th.U.	441	Large 294, fine 1470	367	Large 412, fine 1837
Rate of feed, pounds per hour	75,857	77,310	73,891	74,940
Mean temperature of feed entering boiler, deg. Fah.	241	254	263	260
Steam pressure on boiler drums, pounds per square inch gauge	209	207	202	205
Steam temperature at superheater outlet, deg. Fah.	702	717	692·2	685
Feed water temperature entering economiser, deg. Fah.	160	170	174·5	171
Air temperature entering heater, deg. Fah.	122	132	92	99
Air temperature entering grates, deg. Fah.	263	278	259·5	—
Air pressure under grates, inches water	0·77	0·7	1·1	0·35
Draught in furnace, inches water	0·16	0·1	0·18	—
Draught at boiler outlet, inches water	0·58	0·72	0·8	0·77
Draught at economiser outlet, inches water	0·88	1·02	1·17	1·16
Draught at air heater gas outlet, inches water	1·24	1·51	1·49	1·62
Mean power required for draught fans, kW	64·5	45	63	63·1
Gas temperature at boiler outlet, deg. Fah.	536	554	551	542
Gas temperature at economiser outlet, deg. Fah.	359	366	349	354
Gas temperature at air heater gas outlet, deg. Fah.	225	232	214	233
Carbon dioxide at boiler outlet, per cent.	13·2	13·5	12·8	12·5
Carbon dioxide at economiser outlet, per cent.	10·5	12·3	11·8	12·4
Carbon dioxide at air heater gas outlet, per cent.	10·1	10·8	10·8	9·6
Oxygen at boiler outlet, per cent.	6·0	5·7	6·4	6·7
Fuel fired per square foot grate area, per hour, pounds	28·8	31·2	28·75	28·2
Heat generated per cubic foot furnace volume, B.Th.U. per hour	25,920	26,580	24,960	25,320
Air used per pound of fuel, pounds	10·99	10·83	10·95	11·17
Air theoretically required per pound of fuel, pounds	7·02	7·07	6·63	6·76
Evaporation per pound of fuel as fired, pounds	7·322	7·274	7·139	6·99
Heat transmitted per sq. ft. of boiler heating surface, B.Th.U. per hour	7,494	7,540	7,135	7,261
Heat transmitted per sq. ft. of superheater heating surface, B.Th.U. per hour	2,483	2,635	2,437	2,331
Heat transmitted per sq. ft. of economiser heating surface, B.Th.U. per hour	937	989	1,007	1,018
Heat transmitted per sq. ft. of air heater heating surface, B.Th.U. per hour	232	243	275	282
Proportion of total heat recovered in air heater, per cent.	3·46	3·52	4·26	4·51
Heat in steam (gross overall thermal efficiency), per cent.	88·64	87·43	87·86	87·46
Heat lost in dry products of combustion, per cent.	1·79	1·74	2·08	2·38
Heat lost by excess air, per cent.	·96	·88	1·27	1·45
Heat lost by moisture in fuel, per cent.	1·05	1·18	1·23	1·08
Heat lost from combustion of hydrogen, per cent.	3·58	3·51	3·52	3·60
Heat lost by unconsumed gases, per cent.	Nil	Nil	Nil	Nil
Heat lost by combustible in ashes, per cent.	·62	·84	·59	·92
Heat lost by radiation and otherwise, per cent.	3·36	4·42	3·45	3·11
Heat absorbed by auxiliaries, per cent.	1·04	·83	1·06	0·98
Overall thermal efficiency based on gross calorific value of coal as fired and deducting heat required for auxiliaries	87·60	86·80	86·80	86·48

The water was measured by a Kent Venturi feed-water flow indicator, specially constructed for boiler testing. This instrument, an illustration of which is given in Fig. 14, was connected in the feed main to the economiser. Readings were taken every half minute, and averaged up every five minutes, allowance being made for any difference in gauge glass level. Altogether, 5280 readings were taken during the series of tests. The meter having been calibrated for water at 160 deg. Fah. and 210 lb. pressure, the correction for test conditions was entirely negligiable. It was examined and verified by the makers before the trials began and a representative of the makers was present during the trials.

Temperatures were taken at 15-minute intervals by electrical distance thermometers supplied by the Cambridge Instrument Company, and all the points were checked with the standardised testing coils. Observations of temperature were made in respect of (1) water entering the economiser; (2) water entering the boiler; (3) steam leaving the superheater; (4) gases leaving the boiler at three points across the exit; (5) gases leaving the economiser at three points across the exit; (6) gases leaving the air heater at three points across the exit; (7) air entering the heater at the eye of the induced draught fan; (8) air leaving the heater at the bottom of the hot air downtakes; and (9) air on firing floor. Altogether 2720 temperature readings were taken.

Draught readings were taken at the outlets of the boilers, economisers, and air heaters, under the grates and over the fires. In all, 1280 readings of draught were taken. The steam pressure was measured by standard gauges at the boiler drums and in the outlets of the superheaters. The percentage of CO_2 in the gases was measured continuously at the centre of the boiler and economiser outlets, and at the eye of the induced draught fan. Three Mono duplex recorders were employed for this purpose and check tests were made by an Orsat apparatus. The sampling of the coal used on the trials was carried out as follows:—About 2 lb. were taken from each 2-cwt. barrow load before the latter was weighed, and the samples so collected were placed in an air-tight bin. At the end of each trial the bins were emptied and a moisture sample taken as quickly as possible. The remainder of the coal was then thoroughly mixed and quartered down to a 2-cwt. sample. This was passed through the crushing machine, mixed and quartered to obtain the final sample for the laboratory. The ashes were weighed and spread out on the floor of the boiler-house basement, where they were broken up by hand. Scattered samples were taken, mixed and quartered down to the final sample of about 50 lb.

This brief summary of the procedure adopted in making the trials is sufficient to show the care taken to ensure accuracy. A confirmation of the reliability of the results is given by the independent computations of Messrs. Babcock and Wilcox, who took their own readings and worked out the results for themselves. They based their calculations upon the calorific values of the fuel obtained in the Grove-road laboratory, as their own tests agreed with them almost absolutely. As it is so rarely that there is so effective a check upon boiler trials as in the present case, we give in Table XIII. some comparative figures, which, moreover, serve a most useful purpose in showing the measure of agreement which may be expected between competent independent observers of the same trials.

TABLE XIII.—*Comparison of Boiler Trial Results Obtained Respectively by London Power Company and Babcock and Wilcox, Ltd., on Simultaneous Dates.*

	London Power Company (official).				Babcock and Wilcox, Ltd. (independent).			
Boiler number	26	27	29	30	26	27	29	30
Rate of evaporation, lb. per hour	75,857	77,310	73,891	74,940	75,843	77,310	73,696	74,940
Heat lost in chimney gases, per cent.	7·38	7·31	8·10	8·51	7·7	8·7	9·2	9·65
Heat lost in ashes, per cent.	0·62	0·84	0·59	0·92	0·6	0·6	0·4	0·89
Heat lost by radiation, &c., per cent.	3·36	4·42	3·45	3·11	3·3	3·3	2·1	2·65
Heat transmitted to boiler, per cent.	88·64	87·43	87·86	87·46	88·4	87·4	88·3	86·81
Heat utilised by auxiliaries, per cent.	1·04	0·83	1·06	0·98	1·2	0·8	1·4	1·14
Net overall thermal efficiency, per cent.	87·60	86·60	86·80	86·48	87·2	86·6	86·9	85·67

NOTE.—The heat used by the auxiliaries, namely, the stokers, forced and induced draught fans, was computed from the electrical input to the motors, on the basis of 18,900 B.Th.U. per kilowatt-hour of input.

It will be noticed that the mean of all the official trials, as computed by the London Power Company, shows a net efficiency, after deduction of auxiliary power and taking the higher calorific value of the fuel, of 86·87 per cent. The mean of Messrs. Babcock and Wilcox's determinations was 86·59 per cent. Both these figures are extraordinarily good, and the closeness of the agreement between them is noteworthy. An additional proof of the desire of both parties to ensure accuracy is to be found in the fact that Messrs. Babcock and Wilcox have so far refrained from giving themselves the benefit of any doubt, that the average of the results claimed by them is actually lower than that of the official figures of efficiency.

Want of space forbids us to give more detailed figures of the tests themselves, but we reproduce in Fig. 15 a graphic record of some of the data taken during the normal load trial of No. 26 boiler. Fig. 17 is a similar record of the overload trials of the same boiler. The diagrams are self-explanatory. In considering the latter of them it must be remembered that the object was neither to obtain a very high efficiency nor to measure the efficiency actually obtained, but rather to see how much steam could be

generated without trouble with the grates or the emission of smoke. During these trials the CO_2 at the centre of boiler outlet averaged 13·6 per cent.; at the centre of economiser outlet, it averaged 10·5 per cent.; while at the eye of the induced draught fan it was 9·5 per cent. For the normal load trials the corresponding figures were 13·2, 10·5, and 10·1 per cent., all averages being obtained from the Mono recorder charts. The evaporation obtained on overload of the four boilers have already been given in Table XI. The rise in superheat when boilers are forced is evident by a comparison between Figs. 15 and 16, and in this connection the figures in Table XIV. are interesting.

Another result of forcing a boiler is to cause a sensible pressure drop between the drum and the superheater outlet, owing to the resistance experienced by the greater quantity of steam passing through the superheater. The effect is enhanced by the higher superheat and therefore the greater specific volume of the steam at overloads. In the case of the boilers in question the pressure drop through the superheater did not exceed 2 lb. per square inch so long as the normal rating of the boilers was not exceeded. At an overload of 25 per cent. the pressure drop was 5 lb., increasing to 18 lb. at a rate of steaming 36 per cent. above the normal.

TABLE XIV.—*Temperature of Superheated Steam at Various Loads.*

Boiler No.	Normal load. Steam temperature.	Overload. Steam temperature.
26	702°	739° at 36·5% above normal rating
27	716°	778° at 44·5% " "
29	692°	740° at 41·0% " "
30	685°	739° at 37·5% " "

The increasing use of air heaters in connection with power station work lends a special interest to the records of the performances of the air heaters at Grove-road. In Fig. 16 the temperatures of both gas and air at the inlet and outlet of the heaters are shown graphically, the records extending over practically the whole of the year 1927. In the case of the larger boilers the final gas temperature was on the average 32 deg. Fah. lower than the temperature of the air to the grates. The air heaters on the four smaller boilers were smaller in proportion to the boiler heating surface, with the consequence that on these boilers the final gas temperature was 67 deg. higher than the combustion air. The average figures for the year 1927 are given in Table XV.

The 60,000 lb. boilers, with their smaller heaters, thus raised the air temperature by 112 deg. Fah. and lowered the gas temperature by 95 deg. Fah. In the 70,000 lb. boilers the air temperature was raised by 150 deg. Fah. and the gas temperature reduced by 130 deg. Fah. Since there is no material difference between the specific heat of air and of flue gas, it is evident that a considerable proportion of the air entering the furnaces did not pass through the heaters at all, but entered above the grates or elsewhere. The very low average final gas temperature on boilers Nos. 26 to 31 will be remarked. The final temperature at times fell as low as 180 deg. Fah. Under such conditions the dew point of the layers of gas in immediate contact with the plates was approached, and on two heaters, in which matters were aggravated by the access of rain in wet weather, a certain amount of rusting was experienced until alterations to the ash collectors were made.

TABLE XV.—*Average Results of Preheaters for Year 1927.*

Temperatures.	Boilers Nos. 22 to 25. Deg. Fah.	Boilers Nos. 26 to 31. Deg. Fah.
Air entering heaters	125	101
Air entering grates	237	251
Gas entering heaters	399	349
Gas leaving heaters	304	219

Another question of increasing importance to power station engineers is that of the discharge of dust from the chimneys, especially with short stacks and mechanical draught. At Grove-road grit collectors of the Davidson type are fitted on the discharge of the

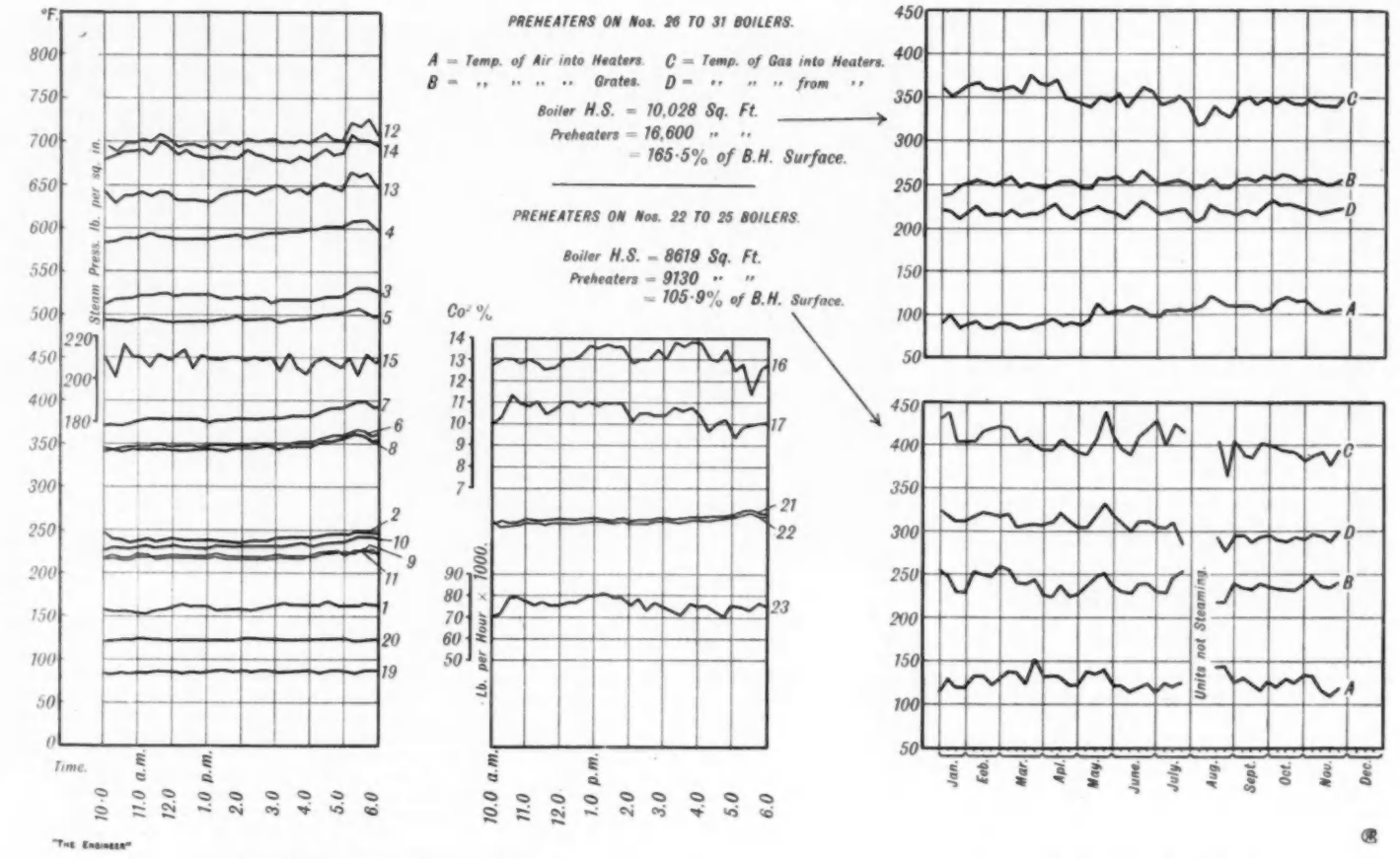

PREHEATERS ON Nos. 26 TO 31 BOILERS.
A = Temp. of Air into Heaters. C = Temp. of Gas into Heaters.
B = " " " " Grates. D = " " " from "
Boiler H.S. = 10,028 Sq. Ft.
Preheaters = 16,600 " "
= 165·5% of B.H. Surface.
PREHEATERS ON Nos. 22 TO 25 BOILERS.
Boiler H.S. = 8619 Sq. Ft.
Preheaters = 9130 " "
= 105·9% of B.H. Surface.
°F.
Steam Press. lb. per sq. in.
Co² %
Lb. per Hour × 1000.
Time.
10·0 11.0 a.m. 12.0 1.0 p.m. 2.0 3.0 4.0 5.0 6.0
Jan. Feb. Mar. Apl. May. June. July. Aug. Sept. Oct. Nov. Dec.
Units not Steaming.
"The Engineer"

FIG. 15—GRAPHIC RECORDS OF DATA

FIG. 16—AIR HEATER RECORDS

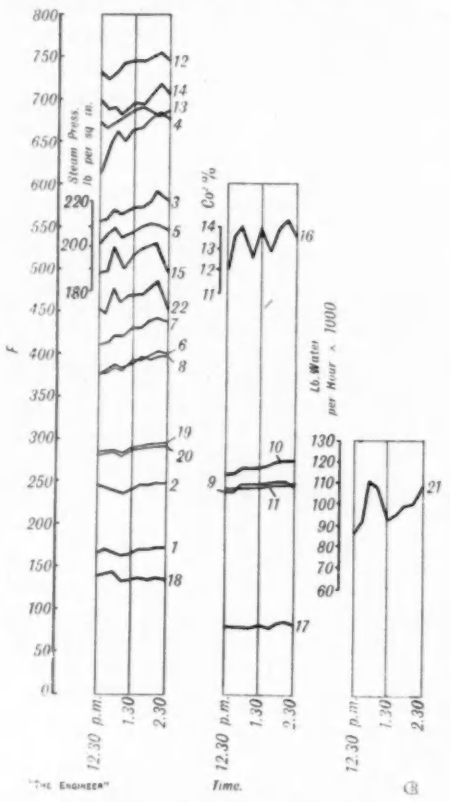


FIG. 17—RECORDS AT OVERLOADS

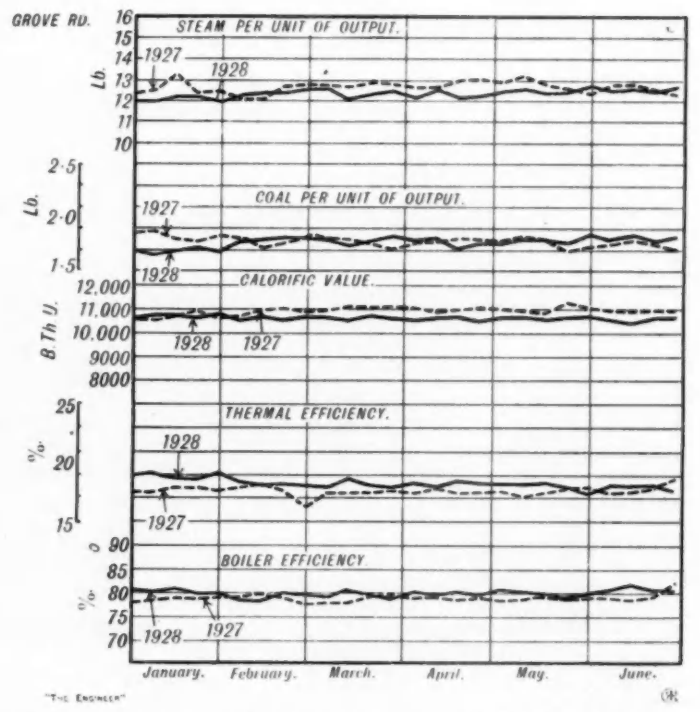


FIG. 18—GROVE-ROAD GRAPHIC RECORD FOR SIX-MONTH PERIODS

induced draught fans, and in accordance with the policy of the station their performances have been carefully tested. The grit prevented by these collectors from escaping into the atmosphere amounted to 460 tons during 1927, or about half of 1 per cent. of the weight of fuel burnt. Table XVI. gives the results of some special tests.

TABLE XVI.—*Tests of Grit Collectors.*

Duration of test, days.	Total coal burnt, tons.	Grit caught, lb.	Grit as percentage of total coal.
7	387	2890	0·383
7	326	3296	0·45
8	331	4736	0·638
10	595	5271	0·429
10	757	7233	0·42

No appreciable wear of the collectors has been found to take place owing to the abrasive action of the grit. The very low temperature of the discharged gases did, however, cause the deposit of moisture from them on the collector walls until the trouble was overcome by lagging the casings. The bottoms of each collector was also protected by a wash of concrete sloping towards a drain in the centre.

We may now return to a consideration of the operation of the station generally. The uniform excellence of the results is shown by Fig. 18, which gives a graphic record for the first six months of 1928, with the corresponding performances during 1927 included for comparison. With coal ranging round 10,600 B.Th.U. higher calorific value a boiler-house efficiency of over 80 per cent. and an overall thermal efficiency of over 18 per cent. are almost continuously recorded, in spite of the drawbacks of the station in regard to load factor, stand-by requirements and circulating water, to which we have already called attention. The boiler plant, to which the results are so largely due, is operated on the principle of knowing exactly what each unit is capable of doing under the best conditions, and seeing that this performance is realised in practice so far as humanly possible, the thorough instrument equipment of the boiler-house makes supervision easy and enables the operators to control their boilers with certainty. The condition of every boiler is recorded in the boiler-house by a curve showing the exit flue gas temperature at full load, day by day. No boiler is allowed to be worked except in cases of emergency if the flue gas temperature at the economiser outlet exceeds 400 deg. Fah. at full load and with 12 per cent. of CO_2. Normally, on the larger boilers, it does not exceed about 360 deg. Fah., and is further reduced to 220 deg. Fah. or less by the air heaters. The standard of boiler-house operation and maintenance is further kept up by the almost constant testing of the boilers. Boiler trials are carried out on an average once a fortnight, the boilers being tested in rotation. The coal is specially analysed for these tests and all records are taken with the fullest care. Not only does this practice ensure that the boilers are maintained in perfect condition, but it keeps before the minds of the operators exactly what every unit is capable of and the importance which is attached to the behaviour of the plant.

(To be continued.)

Regenerative Surface Condensers.

By THOMAS PETTY.

No. II.*

(6) HYDRO-DYNAMICAL RESISTANCE AND REGENERATIVE VELOCITY EFFECTS (*continued*).

As a result of the conjoint labours of numerous celebrated scientists and engineers, the law of the hydro-dynamical resistance to flow in the interior of cylindrical tubes has been placed upon a sound rational basis. So far as the writer is aware, however, no such exhaustive research has been made, or, at any rate, results published, on the somewhat special case of the resistance offered by banks of closely pitched tubes to external flow in a direction transverse to the tube axes. Experiments on single aeroplane struts, besides yielding absolute valves of resistance, have shown that in an air stream at atmospheric pressure, and moving at speeds comparable with those obtaining in condenser tube banks, a plain cylindrical rod offers about seven times the resistance of a well-designed stream-line section strut of equal width transverse to the line of flow. Resistance experiments on single rods, however, suffer in the present connection from somewhat the same disadvantage as single-tube heat transmission experiments, in that the effect upon the conditions of flow of adjacent tubes, or group factor, is absent; and no doubt reliable data of the pressure losses sustained during flow through tubular air coolers, if plotted against a congruent parameter, would provide a better guide to the estimation of this type of resistance. Investigation of the resistance of actual condenser tube banks under operating conditions is attended by much greater difficulty owing to complications arising from the variations in velocity, both transverse to and in line of the axis of steam flow, incidental to the process of condensation at varying temperature difference in a structure offering a varying sectional area for flow; and from the difficulty of determining accurately the depth of mass flow penetration, *i.e.*, the partition of surface dimensions arising from the presence of air. These difficulties are reflected in the data extant for the calculation of resistance, which involve empirical factors having a range of variation of as much as 150 per cent.

In the two pass example dealt with in Table I. (*ante*) the resistance offered by the second pass—*i.e.*, the one first traversed by the steam—is 0·058in. of mercury, and that by the portion of the first pass comprised in the primary section 0·015in., or a total for the whole primary section of 0·073in.

Entrance to the tube bank is by a series of rectangular channels between adjacent tubes, and as these entrances are rounded, there will be practically no contraction. Three usual methods of pitching the tubes with reference to a vertical axis of flow are given in Fig. 2. The shaded portions indicate the

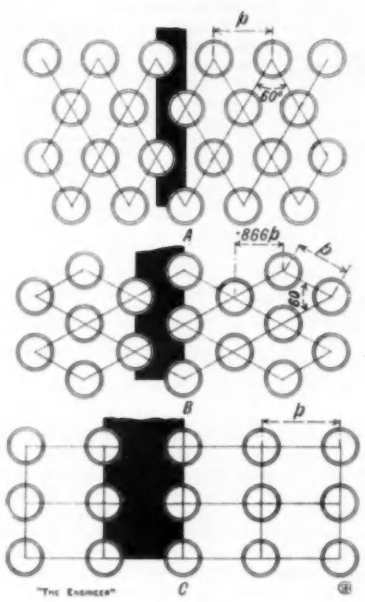


FIG. 2

variation in width of the passage, and as the length is constant, enable the converse variations in velocity of flow due to area factor alone to be readily deduced. The ratio of entrance to approach area is given for arrangements A and C by—

$$R = 1 - \frac{d}{p}$$

and for arrangement B by—

$$R = 1 \cdot 155 \left(1 - \frac{d}{p}\right)$$

Where R = Ratio of entrance to approach area,
d = external diameter of tubes,
p = Pitch of tubes.

Arrangement C is the typical wide pitching used in that part of a tube bank first entered by the steam, in the endeavour to reduce resistance by lowering the entrance velocity. The vertical pitch lines are frequently convergent or radial and an extension of the normal tube pitch dictated by constructional reasons may also be made in line with, as well as transverse to, the axis of flow with, it has been claimed, beneficial effect in reducing resistance. In large units for high vacuum, having deep closed tube banks, the entrance pitches which must be adopted if the resistance is to be kept within reasonable limits become excessively large, to the detriment of economy in both space and material. Although arrangements B and C are favourable to reduced steam velocity, and hence to diminished resistance, they are inferior to arrangement A with respect to the amount of surface traversed by the condensate in falling through the tube bank.

Thus, with equal equilateral pitch in A and B and the same pitch vertically in C, the amount of surface traversed by the condensate in B and C over a given depth of tube bank is roughly 73 per cent. greater than in arrangement A.

Referring in particular to arrangements A and C, let—

P_a = Absolute pressure in inches of mercury at approach to tube bank.
v_a = Velocity of approach to tube bank in feet per second.
v_e = Velocity at entrance in feet per second.
P_e = Pressure drop in inches of mercury at entrance.

Then, assuming the effect of expansion to be compensated by the reduction in weight passing due to condensation on the upper halves of the tubes—

$$v_e = \frac{v_a}{1 - \frac{d}{p}}$$

And—

$$P_e = \frac{P_a\,(v_e^2 - v_a^2)}{2\,g\,H}$$

Or, substituting from the expression for v_e above—

$$P_e = \frac{P_a}{H}\,\frac{v_a^2}{2g}\left(\frac{1}{\left(1 - \frac{d}{p}\right)^2} - 1\right)$$

For the case in question, and with

$d = \frac{3}{4}$in.,
$p = 1\frac{1}{4}$in.,
$q = 0 \cdot 93$.

$$P_e = \frac{1 \cdot 466}{70 \cdot 5 \times 1 \cdot 5 \times 445 \cdot 2 \times \cdot 93} \times \frac{75^2}{64 \cdot 4}\left(\frac{1}{\left(1 - \frac{\cdot 75}{1 \cdot 5}\right)^2} - 1\right) = 0 \cdot 00875.$$

As the steam penetrates the tube bank the pitch of the tubes is reduced, increasing the ratio between the maximum and minimum velocities of flow. Reduction of volume by condensation, however, in conjunction with a less rapid decrease in the area available for flow, produces a progressive lowering of the minimum velocity, with the result that the pressure drop on entrance to the tube row at exit is about 0·00558in. There are on the average about fifty successive conversions of pressure to velocity energy from entrance to exit of a tube bank offering the resistance characteristics indicated. Assigning to each an average pressure drop of, say, 0·00638in., the total resistance, if there were no reconversion of energy, and each separate increase of velocity required to be initiated by a fresh draught upon the stock of energy possessed by the fluid in virtue of its pressure, would be about 0·32in., neglecting friction. As the total resistance is only 0·073in. it is evident that a considerable measure of reconversion of velocity to pressure energy occurs as the steam leaves each row of tubes, the exact degree of reconversion being, however, indeterminate, since the data necessary to apportion the total fall in pressure between that due to imperfect reconversion and to other sources of loss are lacking. The figures given are very rough, of course, and merely serve as a general guide to the conditions obtaining.

It will be noticed from Table I. (*ante*) that, owing to the preponderance of resistance over diffuser action in the approach passage, the temperature at approach is reduced 0·7 deg. Fah. below that corresponding to the vacuum.

With theoretically perfect reconversion and no losses of any description the subsequent passage through the tube bank should be accompanied by a rise in pressure of approximately 0·00292 − 0·000693 = 0·00223in. of mercury, which so far as thermal equilibrium is concerned would permit of a condensate temperature 0·05 deg. Fah. higher than that of approach, an entirely negligible result.

Owing to imperfect reconversion and frictional resistance, however, there is an actual fall in pressure of 0·073in. and a correlated drop in temperature of 1·7 deg. Fah. If a further fall in vapour pressure of 0·027in. is assumed as a result of air concentration, involving a temperature drop of 0·6 deg. Fah., the final vapour pressure becomes 1·366in., with a corresponding temperature of 88·6 deg. Fah.

Assuming that the condensate outlet and collecting area is immediately adjacent to the exit from the primary section of the tube bank, and unaffected by any further fall of pressure in the secondary section, the maximum possible condensate temperature will be 88·6 deg. Fah., or 3 deg. below that corresponding to the vacuum at the exhaust flange.

The particulars given in Table I. (*ante*) illustrate a case combining the favourable factors of low steam speeds through the tube bank, and only moderately high vacuum. With high vacua and velocities the resistance, and consequent depression of condensate temperature, will be greatly increased.

The total resistance of the tube bank is that due to movement at varying velocity over a given average length of track, or to speak more correctly, probably, through a given number of rows of tubes. The length of track and the ratio of the average velocity to that of approach, will vary from condenser to condenser under the same conditions as to duty, &c., and in the same condenser with the conditions of operation.

Dealing with the velocity effect alone, however, and assuming the average velocity to bear a constant ratio to the approach velocity, with the further assumption that resistance in the case of fluids of varying density varies roughly in a direct ratio to the velocity² and inversely as the specific volume V_s, the resistance will vary as $\frac{v_a^2}{V_s}$

v_a, however, varies as V_s, hence in a given condenser resistance will vary as $\frac{V_s^2}{V_s}$

or as V_s simply—that is, approximately inversely as the absolute pressure.

In Table I. the resistance of the main tube bank, *i.e.*, the surface traversed up to the point of extraction of the condensate, only has been dealt with, and on the assumption that this surface is coincident in extent with the primary section as determined by the approximate method of the succeeding section. The subsequent passage of the residual air-steam mixture through the devaporiser is attended by further resistance, which will be a partial determinant of the final thermal level of heat rejection and should be reduced to a minimum, therefore, by suitable care in

* No. I. appeared March 1st.

design, although exercising a negligible direct effect on condensate temperature. The drop in pressure in the devaporiser reaches proportions which are difficult to account for on the grounds of hydrodynamical resistance alone, but which are presumably due to the absorption of energy from the vapour content of the moving stream for the compression of the air.

(7) Partition of Surface Dimensions Arising from the Presence of Air.

With pure water vapour as the fluid operated upon —*i.e.*, assuming no air or other non-condensable gas to be present—the whole of the surface of a condenser would be engaged in mass condensation of the entering steam. Neglecting alike the temperature gradient associated with the usual fall in pressure through the tube bank owing to resistance, and the possible slight rising temperature gradient due to the type of regenerative action associated with changes of velocity, the curve of circulating water temperature, plotted either on a base of tube element length or of surface traversed in series by the circulating water, would be approximately of the form shown in Fig. 3. The curve rises continuously from the point at which the water first enters the tubes, and is of a hyperbolic or logarithmic character, following the law—

$$\text{Log. } (t_s - t_w) = a + b\,x.$$

Where t_s = the temperature of the steam, which will be constant on the accumptions given,

t_w = the temperature of the circulating water at any point in its travel,

$x = \frac{c}{d}$ = fraction of the total surface or tube element length, measured from the outlet end, at which t_w is calculated ;

whilst a and b are constants appropriate to the special conditions of each individual case. The formula is based upon a constant resistance to heat flow at all parts of the surface, an assumption which numerous well-known factors intervene to modify somewhat in practice.

If t_i = temperature of circulating water at inlet, and t_o = temperature of circulating water at outlet, then $a = \log\,(t_s - t_o)$ and $b = \log.\,(t_s - t_i) - \log.\,(t_s - t_o)$; whence $\log.\,(t_s - t_w) = \log.\,(t_s - t_o) + x\,[\log.\,(t_s - t_i) - \log.\,(t_s - t_o)]$, enabling the ordinate of temperature difference at any intermediate point of the surface to be obtained.

Ordinates of temperature difference $t_s - t_w$, if taken at equal intervals of tube element length traversed by the circulating water, form a series in geometric progression. This fact is the basis of the graphical method of drawing the circulating water temperature curve, given the temperature rise r_2 in any individual pass, which is shown in Fig. 4. In this figure θ may be any convenient angle, otherwise the figure is self-explanatory.

The curve for a single pass, if the total rise in circulating water temperature over the pass is known, may be obtained, either graphically, or mathematically by a simpler process than that previously given, by inserting any convenient number of geometric means between $t_s - t_i$ and $t_s - t_o$.

Reverting again to Fig. 3, the hyperbolic or logarithmic mean temperature difference over the whole of the surface is given by the familiar expression—

$$\text{M.T.D.} = \frac{t_o - t_i}{\log_e \frac{t_s - t_i}{t_s - t_o}}$$

The mean axis of flow into the tube bank passes through the intersection of the arithmetic mean temperature difference t_m with the logarithmic temperature curve as shown at A, and departs from the central position between the tube plates by the maximum amount in single-pass condensers, approaching nearer the central position as the number of passes is multiplied ; the actual position in any given case being readily obtained by an extension of the principle indicated.

If the quantity of water circulated per square foot of surface per hour, and K, the coefficient of heat transmission in B.Th.U. per square foot per hour per degree Farenheit logarithmic mean temperature difference, remain constant, the above relations give—

$$\frac{t_s - t_i}{t_s - t_o} = \text{constant.}$$

From whence—

$$\frac{t_s - t_i}{t_o - t_i} = \text{constant,}$$

and—

$$\frac{t_s - t_o}{t_o - t_i} = \text{constant.}$$

Under these conditions, $t_o - t_i$ is approximately proportional to the condenser load in total B.Th.Us. transmitted per square foot per hour, and is in many cases more convenient, because more readily ascertained, than the actual heat flow. Hence, $t_s - t_i$ plotted on such a base of load is a straight line. An example is given in Fig. 5 in which the results of the tests reproduced in Table IV. (*post*) are so plotted, and which is typical of the performance of a well-designed condenser operating under conditions of minimum air leakage. The amount of steam condensed per square foot of cooling surface, or any other basis of condenser load, may also be used if desired.

If the temperature of the circulating water supply, as well as the quantity used, remain constant, the curve of t_s on a base of condenser load is also theoretically a straight line. Actual operating results follow these straight-line laws to a limited extent only ; *i.e.*, at high loads and relatively low vacua. With high vacua generally and with low loads at lower vacua, the air extracting capacity remaining constant, considerable departures from the straight line arise as a result of the varying partition of surface dimensions to be described later, and other factors. Excluding cases of errors in observations or unstable conditions, the points on a $\frac{t_s - t_i}{t_o - t_i}$ diagram from actual test results frequently fall upon a curve, and as the inclination of the straight line to the base varies, under given conditions as to water flow, inversely as the general overall efficiency of the process of heat transmission, a line drawn tangent to the curve, and passing through the origin, indicates, by the position of the point at which it makes the tangent, the load at which the condenser ceases to operate with maximum efficiency. With higher loads the curve rises above the straight line, owing to the fact that in the diagram t_s is assumed constant throughout the condenser, thus ignoring the effects of increased resistance at high loads. With lower loads the curve also rises above the straight line, but in this case owing to the effect of the presence of air in lowering the extent of surface engaged in active condensation. In spite of these and other divergencies, however, the straight line laws, in the light of a study of the circumstances and extent of the conformation to or departure from them of operating results, form criteria capable of considerable utility in the interpretation and prognosis of condenser performance. They are, of course, inapplicable when the quantity of circulating water used, and consequently the velocity of flow through the tubes, is varied to any great extent, since the latter is the principal determinant of the value of K.

When the amount of air to be dealt with by the condenser becomes appreciable, as most often occurs in practice, there is a radical change in the conditions of operation, and the characteristic division of the tube bank into two portions, each having its distinctive function, as described in previous sections, appears. Mass condensation of the steam, in conjunction with a circulating water temperature curve of the character shown in Fig. 3, is no longer coextensive with the total surface, but is confined to the primary section of the tube bank. In the secondary section, which may comprise a considerable proportion of the total surface, very little heat is transmitted, 75 per cent. of the total rise in air pressure in the example given in Fig. 1 (*ante*) involving the condensing out of the residual mixture of a quantity of vapour equal to only about 1·3735 per cent. of the total entering the condenser. The circulating water accordingly flows through this section of the tube bank with very little rise in temperature.

The demarcation between the two sections is not abrupt, of course, the primary and secondary surfaces merging gradually one into the other, as previously stated in Section (3). On the water side of the tubes the degree of apparent sharpness with which the transition is effected largely depends upon the design of the condenser as regards the devaporiser arrangements. It is most definite in cases where, by the use of guiding diaphragms, differential baffles and multiple air suctions, the distribution of the secondary section in line of the tube axis is constrained to approach uniformity most closely. At the opposite extreme is the case in which the secondary section is a more or less free conical formation based upon a single localised air suction, and is therefore formed upon tubes which for portions of their length are engaged in active heat transmission, *i.e.*, constitute part of the primary section, and thus tend to obscure the partition of surface dimensions as revealed by the character of the circulating water temperature curve. It is convenient for purposes of discussion, and to facilitate a quantitative estimate of the relative extent of the two sections, although not perhaps strictly scientific, to assume a sharp and definite division of function, and to neglect the small rise in temperature of the circulating water as it traverses the secondary section. In well-designed condensers with closed tube banks and more than one pass, the upper pass will usually lie entirely within the primary section, and an inter-pass circulating water temperature reading t_i, if reliable, enables the approximate law of circulating water temperature rise in the primary section of the particular condenser to be deduced, from whence the suggested definite partition of surface dimensions may be obtained. The discontinuous character of operation on the water side of the tubes which accompanies the presence of air in the steam in appreciable quantities is perhaps best understood by constructing an hypothetical example of a purposely extreme character, as follows :—

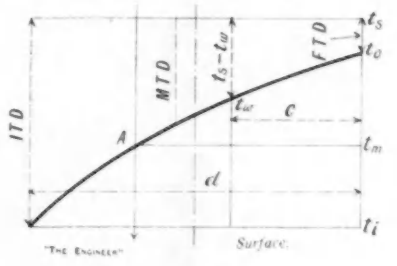


FIG. 3

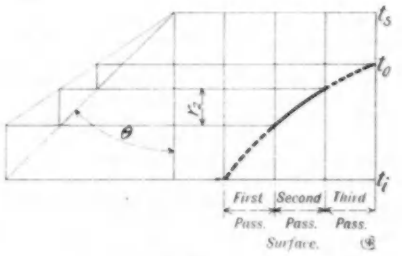


FIG. 4

Let I.T.D. = the initial temperature difference between steam and circulating water, $= t_s - t_i$, for any pass.

and F.T.D. = the final temperature difference between steam and circulating water, $= t_s - t_o$, also for any pass.

Also assume the following conditions :—

Total cooling surface	4,000 sq. ft.
Number of passes	2
Condensing water circulated per hour	1,152,500 lb.
Vacuum	26·044in. of mercury
Corresponding temperature of steam	125 deg. Fah.
Inlet temperature of circulating water	65 deg. Fah.
Mean K for primary section of cooling surface	800

Air leakage, such that 25 per cent. of the total surface, or half the first pass, is occupied in concentrating the air, *i.e.*, constitutes the secondary section, in which the rise in temperature of the circulating water is neglected.

Only 1000 square feet of the lower pass will be occupied in the mass condensation of steam, and for this portion of the surface—

$$\text{I.T.D.} = 125 - 65$$
$$= 60 \text{ deg. Fah.}$$
$$\text{Log}_e\ 60 = 4{\cdot}0944.$$
$$\text{Log}_e\ \text{F.T.D.} = 4{\cdot}0944 - 800\left(\frac{1000}{576{,}250}\right)$$
$$= 2{\cdot}7064.$$

from whence—

$$\text{F.T.D.} = 15 \text{ deg. Fah.}$$

Then temperature of water leaving the portion of the primary section situated in the lower pass—

$$= 125 - 15$$
$$= 110 \text{ deg. Fah.}$$

This mixes with an equal quantity of water from the secondary or air concentrating section at 65 deg. Fah.; hence temperature at entrance to second pass, assuming complete equalisation—

$$= \frac{110 + 65}{2}$$
$$= 87{\cdot}5 \text{ deg. Fah.}$$

The conditions in the second pass are then—

$$\text{I.T.D.} = 125 - 87{\cdot}5$$
$$= 37{\cdot}5 \text{ deg. Fah.}$$
$$\text{Log}_e\ 37{\cdot}5 = 3{\cdot}6202.$$
$$\text{Log}_e\ \text{F.T.D.} = 3{\cdot}6202 - 800\left(\frac{2000}{1{,}152{,}500}\right)$$
$$= 2{\cdot}2322.$$

From whence—

$$\text{F.T.D.} = 9{\cdot}375 \text{ deg. Fah.}$$

giving a circulating water outlet temperature of 115·625 deg. Fah.

This latter result may be obtained more readily from the law of geometrical progression associating successive ordinates of temperature difference at equal intervals of tube element traversed by the cooling water. The portions of tube element length comprised in each pass being equal, the ratio $\frac{\text{I.T.D.}}{\text{F.T.D.}}$

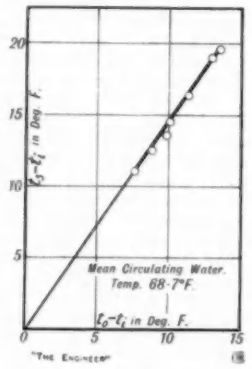


FIG. 5

will be the same for both, and in this case will have the value $\frac{60}{15} = 4$ Hence the F.T.D. for the second pass is $\frac{37 \cdot 5}{4} = 9 \cdot 375$ deg. Fah.

The curve of circulating water temperature is discontinuous as indicated in the upper half of Fig. 6, and a mean curve, based on the average temperature reading at the junction of the passes, such as that

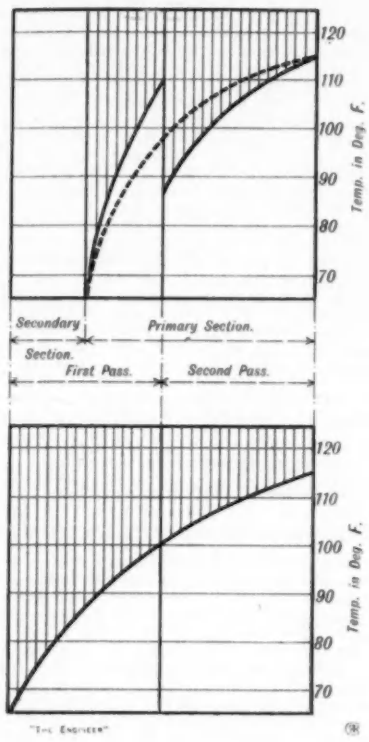


FIG. 6

shown dotted, conceals the fact that the actual rise in temperature is in accordance with the law—

$$\text{Log}\ (t_s - t_w) = a + b\,x.$$

The value of K for these conditions, when calculated from the initial and final temperatures of the circulating water in the customary manner—*i.e.*, ignoring the fact that 25 per cent. of the surface is inoperative as regards actual condensation, and assuming the hyperbolic temperature curve shown in the lower part of Fig. 6—is 537.

The approximate extent of the secondary surface for any actual case, provided t_i, $t_{\frac{1}{2}}$, t_o, and t_s are known, may be readily calculated in the following manner. Referring to Fig. 7—$(\text{I.T.D.})_1$, $(\text{I.T.D.})_2$, and $(\text{F.T.D.})_2$ being known, then since successive ordinates of temperature difference at equal intervals of tube element length are in geometrical progression—

$$(\text{F.T.D.})_1 = \frac{(\text{I.T.D.})_1 \times (\text{F.T.D.})_2}{(\text{I.T.D.})_2}.$$

Let r_1 = actual temperature rise in the portion of the primary section contained in the first pass,

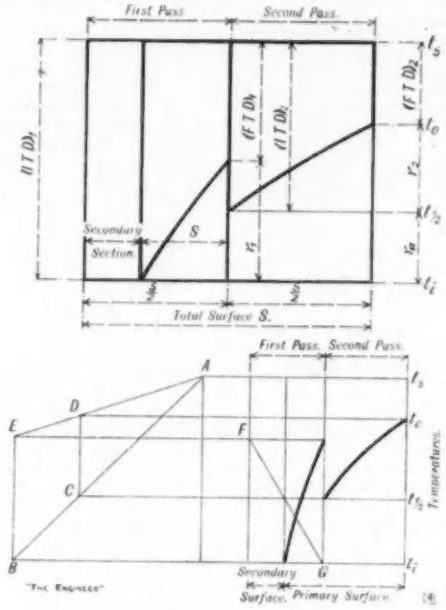
Then $r_1 = (\text{I.T.D.})_1 - (\text{F.T.D.})_1$.

Also let Q = quantity of circulating water in lb. per hour.

Then $Q\,r_2$ = total heat transmitted in the second pass,

and $Q\,r_a$ = total heat transmitted in the first pass;

both in B.Th.Us. per hour, where r_a is the apparent temperature rise in the first pass. The quantity of



FIGS. 7 AND 8

circulating water traversing the portion of the primary section contained in the first pass is

$$\frac{2s}{S} Q$$

and the total heat transmitted in the first pass

$$= \frac{2s}{S} Q\,r_1$$

$$\therefore \frac{2s}{S} Q\,r_1 = Q\,r_a$$

$$\text{whence } s = \frac{S\,r_a}{2\,r_1}$$

The surface comprised in the secondary section is $\frac{S}{2} - s$. Substituting the value of s obtained above and expressing the result as a percentage of the total surface, we have on reduction:—Percentage of total surface in secondary or air concentrating section

$$= \frac{50}{r_1}(r_1 - r_a).$$

A graphic method of determining the extent of the secondary surface is given in Fig. 8, in which the construction follows the order of the lettering.

For the sake of simplicity the discussion of discontinuous action on the water side of the cooling surface, given above, has been confined to the case of condensers with two passes, but the method may be extended readily to cover cases of any greater number of passes. The effect of the temperature gradient on the steam side due to resistance has also been neglected, but may be easily included by suitable modifications if desired.

Table II. has been drawn up to indicate the varying extent of the air concentrating section, as determined by the above expression, in large two-pass power station condensers working at various loads under modern operating conditions as to air leakage. The examples given have been calculated from published data drawn from various sources, and the accuracy of the results in column 9 is entirely contingent, of course, upon the extent to which the inter-pass reading faithfully represents the mean temperature of the water entering the second pass. The turbulence which characterises flow in the inlet section of the waterhead, and which, it has been suggested, is the primary cause of the erosion of condenser tubes,* tends to give place to flow of a laminar character in the return water box and the outlet section of the waterhead, with the result that some uncertainty attaches to localised temperature observations from the two latter sections.

(To be continued.)

TABLE II.

1	2	3	4	5	6	7	8	9	10
Number of test.	Steam condensed per hour in lb. per sq. ft. of total cooling surface.	Vacuum in inches of mercury, barometer at 30in.	Pressure drop from exhaust flange to air pump suction in inches of mercury.	t_i, deg. Fah.	$t_{\frac{1}{2}} - t_i$, deg. Fah.	$t_o - t_{\frac{1}{2}}$, deg. Fah.	$t_s - t_i$, deg. Fah.	Per cent. of total surface comprised in secondary section.	Condensate temperature compared with temperature corresponding to vacuum, deg. Fah.
1	5·1	29·07	—	35·6	0·9	9·4	41·1	44·75	− 25·3
2	5·0	29·15	—	34·6	1·0	6·4	39·4	40·8	− 24·1
3	5·0	29·11	—	35·5	2·4	11·3	39·9	37·3	− 23·5
4	5·02	29·06	—	35·6	2·95	16·2	41·4	39·6	− 20·8
5	4·2	29·36	—	36·0	2·0	26·0	29·6	46·1	− 17·6
6	4·2	29·37	—	36·0	2·0	24·0	29·2	45·75	− 15·2
7	8·8	28·87	—	40·0	2·0	29·0	44·1	46·5	− 14·1
8*a*	6·6	29·23	—	47·78	4·22	8·59	23·16	10·46	− 12·04
9	10·125	28·99	—	35·8	5·5	20·5	43·35	34·0	− 11·75
8*b*	8·25	29·18	—	47·0	5·0	10·2	25·8	11·3	− 11·21
10*a*	6·29	29·12	0·2	45·0	4·05	10·42	30·1	22·5	− 9·6
10*b*	8·3	28·79	0·279	46·0	8·5	16·57	38·7	9·125	− 9·5
10*c*	6·29	29·08	0·2	46·6	4·54	11·62	29·8	22·8	− 8·48
11	6·5	29·33	—	37·0	1·0	27·0	30·0	48·1	− 7·0
12	5·67	28·4	0·16	77·0	4·0	9·0	16·7	19·6	− 5·7
13	6·5	29·32	—	37·0	6·0	29·0	30·4	39·5	− 5·4
10*d*	4·75	29·24	0·076	47·0	3·9	9·7	23·4	21·9	− 4·9
14	8·8	29·03	—	40·0	14·0	29·0	37·9	20·6	− 2·9
15	9·07	28·9	0·26	62·7	6·8	11·2	19·1	2·925	− 2·7
16	3·15	29·6	0·03	38·0	4·5	10·0	14·5	21·8	− 0·5
17	7·74	28·47	0·13	72·3	3·2	10·2	19·95	30·85	− 0·35
18	7·85	29·09	0·1	35·0	5·2	14·0	41·0	24·25	—
19	4·125	29·27	0·11	40·78	7·06	13·02	28·62	5·43	+ 0·36
20*a*	6·39	29·19	0·28	42·0	6·0	11·0	30·6	1·615	+ 0·9
21	10·72	27·54	—	77·5	8·0	17·5	30·55	18·9	+ 1·45
20*b*	5·2	28·5	0·05	82·0	4·0	8·0	9·6	20·8	+ 2·4
22	6·32	28·74		69·8	5·4	10·8	16·2	16·66	+ 2·7

The German Locomotive Industry.

SOME interest will no doubt be manifested in this country in the developments which are proceeding in the German locomotive industry, which in pre-war times became a very keen competitor of the British industry, and has carried on this rivalry as far as possible down to the present time. The precise position of the industry to-day may be stated in a few words: Too many firms have embarked upon locomotive building, with the result that the productive capacity of the works has been considerably increased. At the same time, both home and foreign orders have greatly diminished. Hence the industry is in a state of extreme depression.

Before entering more fully into the question, attention may be directed to the accompanying table, which shows the total sales of German locomotives as from the end of 1909, while the exports, included in the totals are indicated separately. These statistics were given in a petition which was placed before the Government of the Reich in August, 1928, by a group of four locomotive firms, when the grant of a credit of 50,000,000 marks to the Reich Railway Company was asked for, to enable the company to place orders for locomotives with those particular firms which, as a result of their activity in foreign markets, could be considered as productive undertakings.

German Turnover in Locomotives.

Year.	Total sales, No.	Weight, metric tons.	Exports, No.	Weight of exports, metric tons.
1910	2,139	148,679	809	48,106
1911	2,203	133,897	923	39,909
1912	4,052	202,593	1,355	49,483
1913	3,782	159,026	1,457	40,240
1914	3,022	149,299	739	22,780
1922	3,787	258,242	1,890	130,659
1923	2,171	141,286	647	26,747
1924	1,451	85,810	480	16,730
1925	1,140	41,534	596	22,994
1926	615	25,332	400	14,822
1927	870	33,213	430	16,358

Two further petitions have now been presented to the Reichstag and the Prussian Prime Minister respectively, asking for the grant of a credit of 15,000,000 marks so as to enable the Reich Railway Company to allocate orders for 100 locomotives, it being suggested that the payment to the firms concerned should be suspended for a time. In other words, they offer to execute the order on credit. The petition of last August was a remarkable document from the standpoint of the information which it contained, in addition to the statistics reproduced in the table, and it threw a lot of light on German competition throughout the world. From it it was evident that had it not been for the former large home demand, the German firms would in all probability never have gained such a strong hold on external markets.

In the course of the first petition, which is largely repeated in the two recent petitions, it was pointed out that before the war the annual requirements of the German State Railways amounted to from 1600 to 1800 locomotives. To these were added the orders placed by the private railways, and as a result of this large inland sale, it was possible for the German industry so successfully to compete abroad that at times it dominated all free markets in the world. In the pre-war period the exports numbered 1400 in round figures, and the total turnover in 1912 and 1913 represented a value of about 200,000,000 marks—say, £10,000,000—in each year. But between the years 1924 and 1928 the orders given by the Reich Railway Company only averaged 120 locomotives per annum, or, say, 7 per cent. of the normal pre-war contracts. At the same time, the petition stated, the export conditions had greatly deteriorated, partly through the general increase in the costs of production and partly through the dumping practised by countries with a depreciated currency; but,

* "Some Investigations into the Cause of Erosion of the Tubes of Surface Condensers," the Hon. Sir Charles A. Parsons, K.C.B., D.Sc., F.R.S., Institution of Naval Architects. April, 1927.

above all, because foreign countries which were formerly supplied by Germany—Spain and Denmark—had developed their own locomotive industries, and Italy, Sweden and Czecho-Slovakia, which formerly were scarcely able to meet their own requirements, have even successfully embarked upon the export trade.

It was further stated in the petition that German locomotive firms had certainly made considerable export efforts, but almost all foreign orders, which were announced to the public as great successes, were transactions which resulted in a loss. It was submitted that the further continuance of this fight was impossible, unless a reserve was found in the inland market. The measure of the catastrophe, the petitioners urged, was illustrated by the above-quoted statistics, which showed the reaction of the situation caused by the war and the period of inflation. The picture was accentuated by the fact that the export orders which in former years were very profitable, were now, as already stated, mostly to be regarded as highly competitive transactions.

The official reply given to the first petition, whilst announcing the impossibility of further orders being placed owing to the financial position of the Reich Railway, suggested that it was the duty of the locomotive industry itself to set its own house in order by reducing the number of works and by changing over to the manufacture of other products. Since that time when the signatories to the petition had formed a community of interests, the process of concentration in the industry has made further progress. Besides the Henschel-Borsig-Schwartzkopff-Maffei combination, which presented the first petition, and whose arrangement merely represents a distribution of types, so-called delimitation agreements have been entered into between the firms of R. Wolff, the Stettin Vulkan, Hartmann, Humbolt and Karlsruhe, and if the similar agreements now pending between Linke-Krupp and Hohenzollern-Esslingen are carried out, the total German productive capacity in locomotives will have been reduced by quite 20 per cent. It is these actions and expectations which the locomotive industry adduces in support of the two fresh petitions to the Reichstag and the Prime Minister of Prussia.

The Rotor Bearings of Electricity Meters.

On Thursday, February 28th, a paper on "The Rotor Bearings of Electricity Meters" was read before the Institution of Electrical Engineers by Mr. W. Lawson who drew attention to the necessity for improving the reliability of meters. The period of sustained accuracy needs to be extended in order to reduce the work of exchanging meters, which is becoming increasingly difficult to grapple with. It is submitted that the solution lies in increasing the durability of bearings, and particularly the bottom jewel and pivot, which constitute the footstep bearing. In Section I. of the paper typical bearings found in electricity meters are illustrated and described, and the principal features are referred to, whilst Section II. is devoted to a study of the movements of the pivots under load which contribute to the wearing of the bearings. An explanation is given in the latter section of a method devised by the author of compensating for fluid friction in mercury motor meters in which the upward movement is put to practical advantage. The vibratory movements of the rotors of A.C. meters produced by the action of the voltage and current fluxes are dealt with, and the differences observed in the amount of vibration exhibited by different designs are commented upon. In Section III. of the paper the condition in which bearings are found after the meters have been removed from service is discussed; the frequency of the occurrence of defects in the bottom jewel is dealt with, and the variety of forms which they take as revealed by the microscope are described. Examples of long-life jewels are given, and the difficulty of drawing any conclusion as to the cause of wear is pointed out. The extreme obscurity of the problem is recognised, but the author suggests some possible explanations, and certain lines along which research might prove fruitful. Section IV. of the paper deals with a special application of the diamond-capped bearing in connection with high-tension polyphase meters, whilst in Section V. the author endeavours to formulate some opinions on the bearing questions based on the experience and investigations set out in the paper.

It is not claimed that a general solution of the bearing problem has been found or is in sight, and it is recognised that few definite conclusions can be arrived at from the experience and observational and experimental work detailed in the paper. It is thought, however, that some advantages may be gained in an endeavour to sum up the situation, and to that end the author formulates his views in the following paragraphs:—

(1) Where the cost of a diamond bearing represents a small item in the total cost of the metering equipment, it offers a complete solution of the bearing problem. With low-priced meters its use from a financial point of view is debatable, but might be justified in the long run. Users of meters should seriously consider the question of adopting diamond jewels in all meters of, say, 50 kW and over, and manufacturers should assist in this by placing themselves in a position to supply them.

(2) In a.c. meters, vibration contributes to the wearing of the jewel and becomes more destructive with increased working forces in the meter. Care should be taken not to overload meters heavily, even if they are designed for accurate performance under such conditions.

(3) Oil immersion extends the life of the jewel and reduces the effect of wear on the accuracy, but is subject to physical changes and cannot be trusted for sufficently long periods.

(4) The agate pivot provides a possible means of solving bearing troubles in mercury motor meters, which would be subject to very light action and free from the possibility of damage in transit.

(5) Given bearings of the durability of the diamond, reasonably protected against dust accumulation, the pivots of all moving parts being made of rustless material and no oil being used, there is no reason why with modern a.c. meters the period of exchange should not be extended to ten years or even longer.

(6) Durability tests of jewels, if carried out, as they should be, under normal working conditions, necessarily extend over long periods of years and consequently do not constitute a sufficiently rapid means of obtaining results. Further, they offer no prospects of determining the root cause of wear upon the discovery of which depends the whole solution of the problem of producing bearings of uniformly high durability from the cheaper stones.

The solution of the problem will come from the scientific research laboratory rather than from the maintenance side, but co-operation of the workers in both fields of inquiry would be a step in the right direction.

Infra-Red Spectra.

An experimental Friday evening discourse on "Infra-Red Spectra," was given on March 1st at the Royal Institution by Sir Robert Robertson, F.R.S. Reference was made to the discovery by the elder Herschell of radiations beyond the red end of the solar spectrum, and their existence was demonstrated by the quenching of phosphorescence by radiation beyond the red. To illustrate the position and extent of the region commonly taken as the "infra red," use was made of the diagram of over sixty octaves of electro-magnetic waves, prepared by Dr. F. E. Smith, shortly after all gaps had been filled, from gamma rays to the longest radio-waves, and attention was called to the fact that it was in the Royal Institution that the first clue was obtained by Faraday to the electro-magnetic nature of those lying in the visible region.

After discussing the limitations of other methods of investigating infra-red radiations, a modern spectrometer, fitted with thermopile and galvanometer, was described, and with it the experiment of mapping an absorption band of a gas—ammonia—was made. Thus from the difference in energy for progressive wave-lengths, as shown by the throw of a galvanometer spot when an empty tube and one containing the gas were alternately brought into the optical path of radiation from a Nernst glower, a curve showing an absorption band was traced on the blackboard.

The origin of oscillation and rotation bands, of which oscillation bands are due to vibrations of the atom in a molecule, was then discussed. These, Sir Robert explained, were reflected in the main bands found in the infra-red both in emission and in absorption spectra, and frequently had a harmonic relationship with one another. Rotation of the molecule was shown by bands in the far infra-red and in the near infra-red by fringes imposed on the oscillation bands. From the difference in frequency of these fringes the moment of inertia of the rotating molecule could be calculated, and values for the length of the moleclue agreeing with those reached by totally different methods, could be obtained.

Information deduced from the study of infra-red spectra was then discussed, and it was pointed out that, not only could the frequency of the oscillations of the atoms in a molecule and the frequency of rotation of the molecule itself be determined, but also that models illustrating molecular structure could be deduced. Assistance was thus afforded to the chemist, who had also this further means of investigating the presence of specific groups in related compounds. Mention was also made of its importance in the study of radiation given off in the processes of combustion and of explosion, and in the investigation of stellar radiation and temperatures, and the secular effects of differences in climate due to changes in intensity of solar radiation.

The plea for more extended investigation of the infra-red region of the spectrum in this country was put forward by the lecturer. Not only, he said, did it afford valuable data for the theoretical physicist from the point of view of the quantum theory and of wave-mechanics, but it was also becoming increasingly useful for determining chemical structure and suggesting molecular models. In all questions of radiation, whether from stellar bodies or from ordinary processes of combustion, there was much to be learned by observing effects in the infra-red. The dynamical behaviour of atoms in the molecule and of the molecule itself as revealed by the study of this region of the spectrum, appeared to be a subject worthy of much more attention than was being given to it in this country.

SIXTY YEARS AGO.

Disputes between the Government and inventors concerning the rewards to be given when private inventions are adopted for official use are by no means things of to-day. In the past occasions arose when the subject aroused intense public feeling. In many instances the Government's treatment of inventors was such as to encourage the belief that the submission to it of inventions of naval, military or other value was not desired. It was openly alleged that in not a few cases inventions after being rejected with scant ceremony had been adopted later on as original on the part of Government officials and without reward to or recognition of the private individuals who had submitted them in the first instance. When it was found that a claim for reward could not be wholly brushed aside an endeavour would be made to tire the claimant out by all manner of unnecessary delays. The final adjudication, it was repeatedly alleged without being contradicted, was placed in charge of the departmental legal heads, who were allowed a percentage commission on any abatement of the claim which they might succeed in effecting. Legal actions were from time to time instituted by inventors against the Government. The culminating point came in the celebrated case of "Feather *v.* the Queen." The finding in that case was that an inventor had no legal right in any matter relative to the use of his invention by the Government. So far as the Government desired, it could in effect make free use of a private invention as if the inventor were an outlaw. Although such was the state of the law as determined by the verdict of 1865, there were, it seems, comparatively few cases in which the inventor remained totally unrewarded. When Mr. Gladstone's Government came into power in 1869 steps were taken to secure the equitable treatment of inventors in the future. The law was allowed to stand as it was, but it was announced that all inventions in future were to be submitted in the first instance to the Under-Secretary of State for the department concerned—to guard presumably against exploitation by minor officials—and that claims for reward would be examined by a Council. Any reward recommended by that Council, after approval by the Secretary of State and the Treasury, would be included in the departmental estimates. Payment was to be made after Parliament had passed the vote for it. In a leading article in our issue of March 5th, 1869, we welcomed the new procedure and pointed out that it had already clearly been applied in the case of Captain Moncrieff and his invention for mounting heavy artillery. Captain Moncrieff's reward covered payment for his drawings, models, &c., a grant of £10,000, a salary of £1000 a year so long as his assistance was required by the Government for the development of his invention, and a final payment of £5000. The legal right of the Government to the free use of any patented invention without the consent of or compensation to the patentee remained in force until January 1st, 1884. The Crown, however, is still entitled to use an invention in the service of the country on terms agreed to between it and the patentee either before or after the use of the invention or in default of such agreement on terms settled by the Treasury after all the interested parties have been heard.

B.E.S.A. SPECIFICATIONS.

SMALL HEXAGON BOLTS, NUTS, SET-SCREWS, &c.

The British Engineering Standards Association has recently issued a new specification for bright hexagon bolts, nuts, screws, &c. A demand having arisen for a series of bolts having British standard Whitworth threads, but with smaller heads than those of the series published in the B.S. specification No. 190, the new standard has been established and designated the British Standard Whitworth (Small hexagon) (B.S.W.S.) series. A corresponding nut is also standardised. The dimensions, other than those of the screw threads, are identical with those of the British standard fine series, published in the B.S. specification No. 191, and the present series is that which has been used in certain branches of industry under the designation "Auto-Whit." The specification is additional to, and does not supersede, the two B.S. specifications Nos. 190 and 191 for British standard Whitworth (B.S.W.) and British standard fine (B.S.F.) bright hexagon bolts, set-screws, nuts, &c.

TRAMWAY TIRES.

The British Engineering Standards Association has just issued a revised edition of British standard specification No. 101 for tramway tires. The specification was first published in 1921, but since that date there has been an increasing use of material of higher tensile strength, and it was therefore decided to prepare a revised edition. Examination of the position showed that there was a sufficient demand for a hard tire to justify its inclusion, and provision has therefore been made in the present issue for two distinct classes, which have been classified according to the tensile strength of the material as grade X and grade Y tires—the former being hardened by heat treatment and the latter being in the "as rolled" condition. The testing requirements of the specification have been modified to provide for both classes of tires. For the grade Y tires a Dropping Test—in which all the tires are dropped from a height of 10ft.—has been substituted for the Falling Weight Test. For grade X tires the Dropping Test is an alternative to the Falling Weight Test at the engineer's option. A new formula, based on current practice, has been incorporated from which the deflection to be obtained in the Falling Weight Test is to be determined.

Copies of either of these specifications—B.S.S. No. 193, 1929, or No. 101, 1928—may be obtained from the British Engineering Standards Association, Publications Department, 28, Victoria-street, Westminster, S.W. 1, price 2s., 2s. 2d. post free.

The Institute of Metals.—The fortieth volume of the *Journal* of the Institute of Metals has just been issued. It is larger than many included in the series that has been issued for several years past, a fact that reflects the increasing importance and amount of metallurgical information that is now available. The first 426 pages, which comprise Section I. include the fifteen papers read at the recent Liverpool meeting and the popular lecture delivered at that meeting by Mr. F. G. Martin, B.Sc., on the subject of "Non-ferrous Metals in the Shipping Industry." The second section is devoted to a summary of metallurgical and engineering literature as published by societies, institutions and the technical Press throughout the world during the past six months.

Royal Society of Arts.—Under the will of the late Thomas L. Gray, the Royal Society of Arts has been appointed residuary legatee of his estate for the purpose of founding a memorial to his father, the late Thomas Gray, C.B., who was for many years Assistant Secretary to the Board of Trade (Marine Department). The objects of the Trust are: "The advancement of the science of navigation and the scientific and educational interests of the British mercantile marine." The Council now offers the following prizes:—(i.) A prize of £150 to any person who may bring to their notice a valuable improvement in the science or practice of navigation proposed or invented by himself in the years 1928 and 1929. (ii.) A prize of £50 for an essay on the following subject: "You are overtaken by a revolving storm. Discuss the handling of a low-powered steamer from the time of the first indication of the approach of the storm until the storm has passed, supposing the ship to be in (*a*) the safe semi-circle, (*b*) the dangerous semi-circle, and (*c*) the direct path of the storm's centre."

The British Industries Fair at Birmingham.

No. III. (*Conclusion*).*

IN opening this article descriptive of some of the exhibits at the Birmingham section of the British Industries Fair we are glad to be able to modify, to some extent, our technical observations concerning representatives on the stands. We do not for a moment go back on what we have already said as to the failure of some manufacturers to make the best use of the Fair—that is to say, the sale of our manufactures both at home and abroad; but we have been rather impressed by the contrast in the attitude of those firms which are concerned with old-established forms of engineering manufacture, and those which are developing comparative novelties.

The visitor to the stand of a steam engine or boiler, a rolling mill or a tube-making firm was, as often as not, greeted at the Fair by a subordinate with no authority to give information concerning the exhibits. On the other hand, the stands in the electrical section, those devoted to refractories and the hardware group, were well provided with technical men or principals really representative of the firms exhibiting. This all leaves one with the impression that while the designing staffs of our big engineering firms are doing all they can to improve their products, the selling organisations are not supporting them adequately. However, we hope that the recent propaganda may produce a better result by the time that the next Fair opens.

Below we conclude our description of the exhibits.

THE RAPID MAGNETTING MACHINE COMPANY, LTD.

The most novel features on the stand of the Rapid Magnetting Machine Company, Ltd., Lombard-street, Birmingham, were (*a*) a hand trolley equipped with a storage battery and a long narrow electro-magnet, which is hung with its working face near the floor,

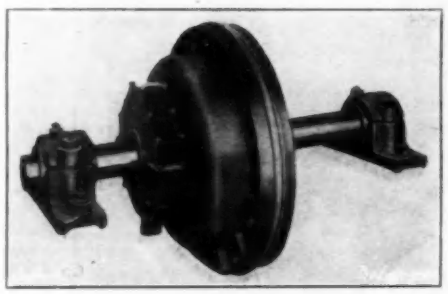


FIG. 24—"MAGNETTIC" CLUTCH—RAPID MAGNETTING

so that it can be wheeled about to pick up swarf, odd tools or any ferrous scrap which may be dropped; and (*b*) the magnetic clutch shown in Figs. 24 and 25. This clutch has been specially designed for machine tool driving and can be made to give a positive drive or to slip at any predetermined overload. It is also very convenient for insertion in the feed mechanisms of machines which have frequently to be stopped and

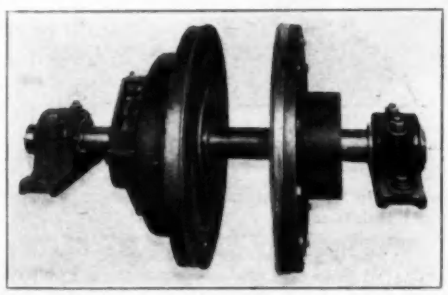


FIG. 25—"MAGNETTIC" CLUTCH—RAPID MAGNETTING

started. It should be pointed out that the shaft and bearings shown in the illustration do not necessarily belong to the clutch, as they were only used for photographic purposes.

THE HACKBRIDGE ELECTRIC CONSTRUCTION COMPANY.

The Hackbridge thermal relay shown in Figs. 26 and 27, which was exhibited by the Hackbridge Electric Construction Company, Ltd., of Hersham, Walton-on-Thames, is designed to protect power transformers against excessive overheating, owing to any cause. The operating range of the device is adjustable between 50 deg. Cent. and 120 deg. Cent. in steps of 5 deg., and each relay is tested and set to an accuracy of plus or minus 0·5 deg. Cent., or one-half a degree Centigrade. Fig. 27 is a section of the instrument. The strip marked C consists of two dissimilar metals welded together and fixed at the base to a steel rod B. Under the influence of increasing temperature, owing to the differential expansion of the two metals, the strip C bends outwards, permitting the spring-

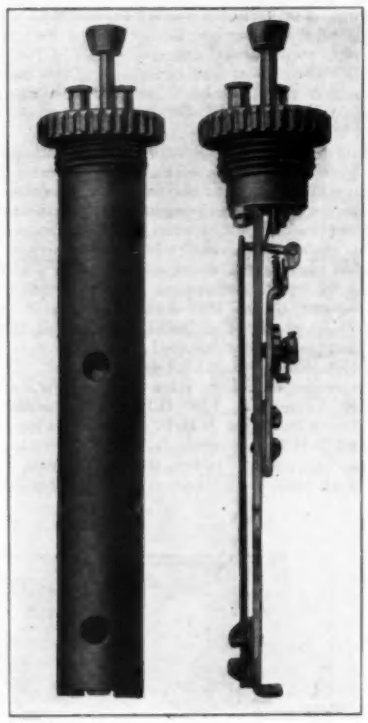


FIG. 26—THERMAL RELAY—HACKBRIDGE

controlled arm G to be released by the pawl D, which then springs up, making contact with H, and so completes the external circuit, in which an alarm or other device may be included. It will readily be understood that the amount of deflection of the strip depends solely on, and is proportional to, the temperature of the surrounding medium. By means of the screw M the support carrying the switch alarm G can be varied in position, and arranged to make any required length of contact with the pawl D. This consequently makes a direct range of temperature operation possible, and permits of accurate calibration and adjustment.

The principle of operation of the Hackbridge "normally closed" relay is identical with that just described, with the exception that the support for the arm G is insulated, and the arm itself is arranged to break contact instead of making it. The whole instrument is preferably immersed in oil, and under such conditions is capable of breaking alternating currents of sufficient magnitude to operate circuit breakers or other devices. Experiments are in progress to determine the applicability of this relay to service other than with transformers, and it has been found that the relay can, within certain limits, be used without immersion in oil for breaking alternating-currents and also small direct currents. As will be recognised, the principle in itself has been successfully applied to other services in the past, such as fire alarms, &c., and the simplicity of the instrument is claimed to give it an accuracy of the highest order.

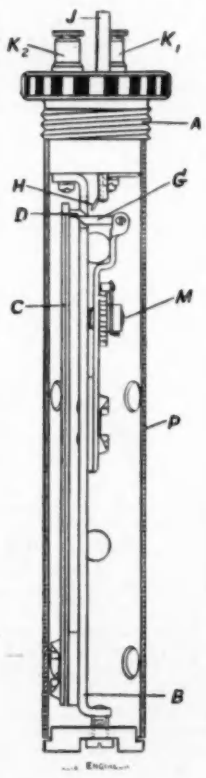


FIG. 27

The apparatus can be made for open circuit operation, or, when used with special danger indicating systems, for closed circuit operation. The latter type can be supplied with a resistance of 1000 ohms, which is connected between the two contacts, the latter designed to carry 6 ampères at 240 volts, but a proportionately lower current at voltages up to 600 can be employed when the contacts are immersed in oil. The relay is mounted in an insulating cylinder P, and is screwed in the cover of the transformer tank by means of a 1in. gas thread. When the tank is under pressure from a head of oil, such as when a conservator is being used, it is necessary to weld or screw a pocket into the lid of the tank, and screw the relay into this pocket, the pocket being first filled with oil. On a transformer without a conservator, the device can be mounted in the lid, and set for operating either when immersed in the oil or merely from the hot air in the upper part of the tank. A model, which is 2½in. longer than the standard, is manufactured. To reset the indicator for operation again, it is only necessary to press the button J, situated between terminals K 1 and K 2. A relay with a remote control switch for resetting is being prepared.

STURTEVANT ENGINEERING COMPANY, LTD.

On the stand of the Sturtevant Engineering Company, Ltd., of 147, Queen Victoria-street, London, there was displayed a representative group of the firm's specialities in turbo-exhauster machinery, specially designed for vacuum cleaning plants and

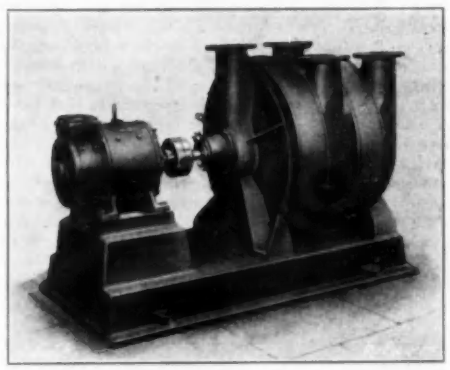


FIG. 28—TURBO-EXHAUSTER—STURTEVANT

pneumatic despatch tube systems. One of the larger exhibits was a horizontal two-stage turbo-exhauster, similar to that illustrated in Fig. 28. The exhauster is of the series-parallel type, there being two exhausters arranged alongside each other, so that they can be run in parallel for pneumatic tube work and in series for vacuum cleaning, which requires a higher suction pressure. This machine is coupled directly to a 10 B.H.P. motor and mounted on a common bedplate. This type of plant illustrated, in combination with a vertical dust separator, is used in connection with vacuum-cleaning plant installa-

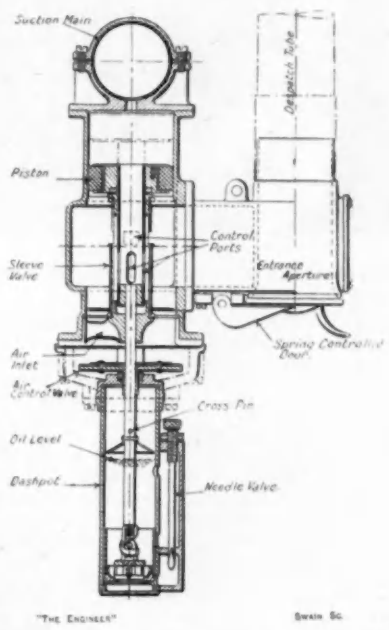


FIG. 29—AIR CONTROL DEVICE—STURTEVANT

tions for large buildings. Smaller types of cleaners, some of which have been specially designed for industrial use, were also displayed.

A typical example was a portable turbine vacuum cleaner for tramcar and omnibus cleaning. It is mounted on a convenient four-wheel truck, which can easily be turned. The truck runs on rubber-tired wheels, and the exhauster is driven by belt from a 4 B.H.P. electric motor.

Another part of the exhibit served to illustrate the Sturtevant system of pneumatic despatch tubes and the means adopted to minimise the work of the exhauster. In a double-tube system there is a

* No. II. appeared March 1st.

series of loop tubes which run from the central station to the sub-station. Air is drawn through these tubes, which are connected to the suction main in parallel, the message carrier travelling through one limb of the loop and returning through the other.

An interesting part of the mechanism is the patented automatic control device illustrated in Fig. 29. Its main object is to reduce the amount of air flowng in the system to the minimum, thereby enabling a small exhauster to be used with an economical use of power, and it is designed to admit air to the suction system immediately a carrier is inserted at either end of the loop. It cuts off the air supply as soon as sufficient air has been admitted to bring the carrier to its destination, and it further provides for the timing of the air when a second or third carrier is introduced, as well as for the automatic resetting of the mechanism. The device is very simple, there being only five working parts. As will be seen from the drawing, the main cylinder with the control piston, its dashpot and the air supply valve with the despatch orifice, are arranged vertically with connections to the suction main and the despatch tube respectively.

The upper part of the controlling piston is hollow, and is connected to the suction main by a small orifice. The piston is furnished with two sets of ports, which enable the upper and lower sides of the piston to be connected one with the other. A sliding sleeve valve moving outside a guide tube closes the ports, and it carries at its lower end a disc which is slightly smaller than the bore of the casing through which the air enters. The air opening is just below the disc, and to the right will be seen the entrance aperture.

After air has been flowing through the tube system for a given time, any further entry of air to the system is prevented by the closing of the air control valve, which is lifted up by a cross pin carried on an extension of the piston-rod. The pressure of the outer air keeps this valve on its seat, even after the piston has dropped. The use of the piston is controlled

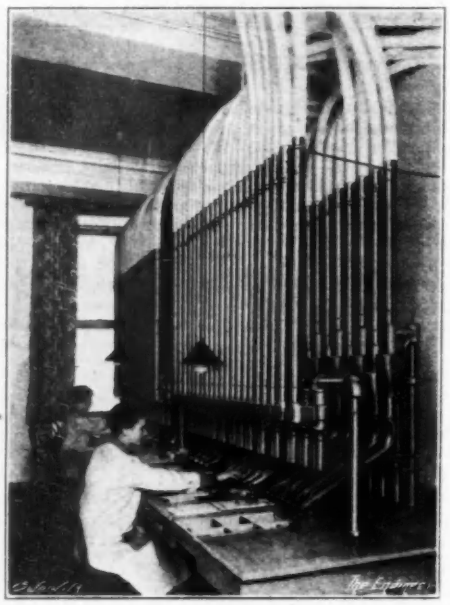


FIG. 30—DISPATCH TUBE INSTALLATION—STURTEVANT

by a dashpot, the rate of travel of which can be adjusted by a needle valve.

When no transmissions have been made for some time, the valve is on its seat and no air can enter the tube system; also, the piston is at its lowest position, as shown, both ports being open and the pressure above and below the piston being equalised. Immediately a despatch door is opened the vacuum is broken, and the air control valve falls under gravity. The flow of air raises the sleeve valve by impinging on the disc attached to it and the upper ports are covered, bringing the full suction pressure on to the top of the piston and causing it to rise at a speed determined by the setting of the dashpot. After a predetermined time interval, which is adjusted to suit the time of the transmission of a carrier, the air control valve is raised to its seat. The sleeve valve again falls, opening the ports communicating between the upper and lower parts of the piston and the main piston drops into the starting position once more. Whenever a door is opened, the piston is automatically reset, so that the air flow timing is dated from the introduction of the last carrier. When a carrier is discharged the piston is not reset, as the inertia of the piston and sleeve valve is sufficient to prevent resetting.

In Fig. 30 we illustrate the application of this apparatus in a forty-tube installation, embodying the latest features in despatch and discharge arrangements. Similar tubes operating on the single-tube system have been supplied to naval ships and some of the larger liners, including the motor vessel "Bermuda" and several of the new Canadian Pacific liners.

BLACKSTONE AND CO., LTD.

The largest exhibit which was shown by Blackstone and Co., Ltd., of Stamford, was the 150 B.H.P. single-cylinder, cold-starting oil engine, illustrated in Fig. 31. Like other engines on the stand, it is designed to operate on the firm's patented spring-injection system, which is familiar to readers of THE ENGINEER. The cylinder bore is 18½in., with a stroke of 27in., and the design is such that full output corresponds to a normal running speed of 195 r.p.m. As will be seen from our illustration, the engine is characterised by its robust construction and it is furnished with a heavy fly-wheel for which an outboard bearing is provided.

Starting is effected by compressed inert gas, which is by-passed from the working cylinder, and stored in a steel container. For the first few revolutions the engine is run on low compression and additional heat is supplied to the combustion space by means of a piece of smouldering rag which is attached to a removable plug in the combustion space. After the requisite fly-wheel momentum has been built up, the engine is put on to full compression and normal ignition takes place. The quantity of fuel oil delivered to the fuel pump is controlled by the governor, and close speed regulation is thereby obtained.

Other engines of the same type which were also exhibited include a 130 B.H.P. horizontal two-cylinder unit and a 14 B.H.P. single-cylinder engine, while a 64 B.H.P. twin-cylinder engine, complete with a dynamo and a switchboard, was also shown.

For small outputs, a series of hopper-cooled engines

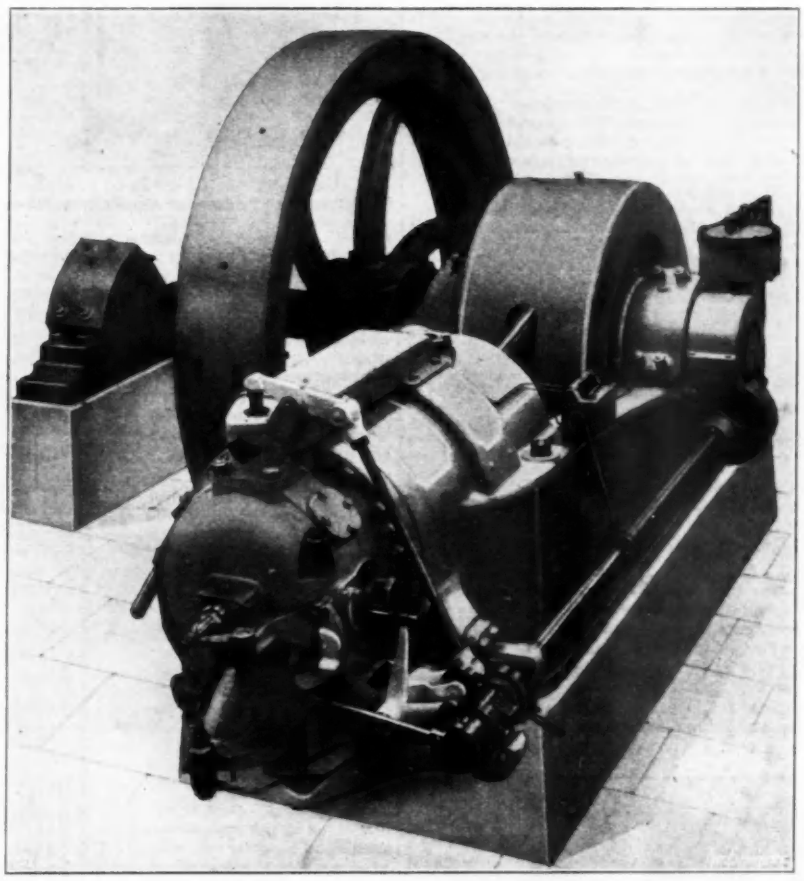


FIG. 31—150 B.H.P. HEAVY-OIL ENGINE—BLACKSTONE

designed to work on paraffin or heavy oils, embracing sizes from 5 to 13 B.H.P., was exhibited.

Other small units included "Blackstone" petrol lighting sets with designed outputs of from 1 to 3½ kilowatts, and portable stationary engines in sizes from 2½ up to 7 B.H.P.

An interesting engine which was exhibited for the first time was the new high-speed vertical model, which has been specially built for tractor and road haulage work. It is designed to run at 1000 r.p.m., and is constructed in two, four and six-cylinder sizes.

In addition to the engines already referred to, the firm exhibited examples of its "unchokeable" centrifugal pumps, which are largely employed for pumping liquids in which solid or sedimentary matter is suspended.

PNEULEC, LTD.

The stand of Pneulec, Ltd., Mafeking-road, Smethwick, Birmingham, was devoted to foundry equipment, among which there were a cupola, a sand-throwing machine and the coke-fired portable mould dryer shown in Fig. 32. As illustrated, the dryer was used for drying out the mould for a turbine cylinder cover. The weight of the casting was 4 tons, and its overall dimensions 8ft. by 8ft. by 4ft. 6in. The size of the pit was 13ft. by 11ft. by 9ft., and the mould was dried

FIG. 32—PORTABLE MOULD DRYER—PNEULEC

out in twenty hours for a consumption of 5 cwt. of coke. The sand-throwing machine works on the principle of a rapidly travelling inclined belt, on to which the sand is shovelled, as has already been described in THE ENGINEER in connection with previous Exhibitions.

THE BRITISH OXYGEN COMPANY, LTD.

There were several new oxygen cutting appliances on the stand of the British Oxygen Company, Ltd., of Angel-road, Upper Edmonton, among which there was the machine illustrated by the drawing Fig. 33. It was a small replica, or rather a component part, of a machine recently supplied to the Great Western Railway for the Swindon shops, and was shown at work on production jobs. The machine exhibited had only one cutting head, but that for Swindon has two heads. These heads can be travelled along a long bed mechanically and are provided with movements so that they can cut out any desired shape. Power for travelling is provided by a ½ horse-power electric motor arranged in the base of the column with a change-speed gear box. The heads run on ball-bearing rollers and are consequently very free in movement, while ball bearings are also provided at all the joints carrying the cutting blow-pipe. All the controls are conveniently arranged, so that the attendant can easily follow the work. For plain straight

cuts the head is simply travelled along the bed with the blow-pipe securely clamped, and should a specially shaped cut be encountered a template is employed to guide the flame. The transition from the straight to the curved cut is effected quite smoothly. The capacity of this machine is 12ft. 6in. by 4ft. 7in. for every length of longitudinal bed.

The large universal cutting machine made by this

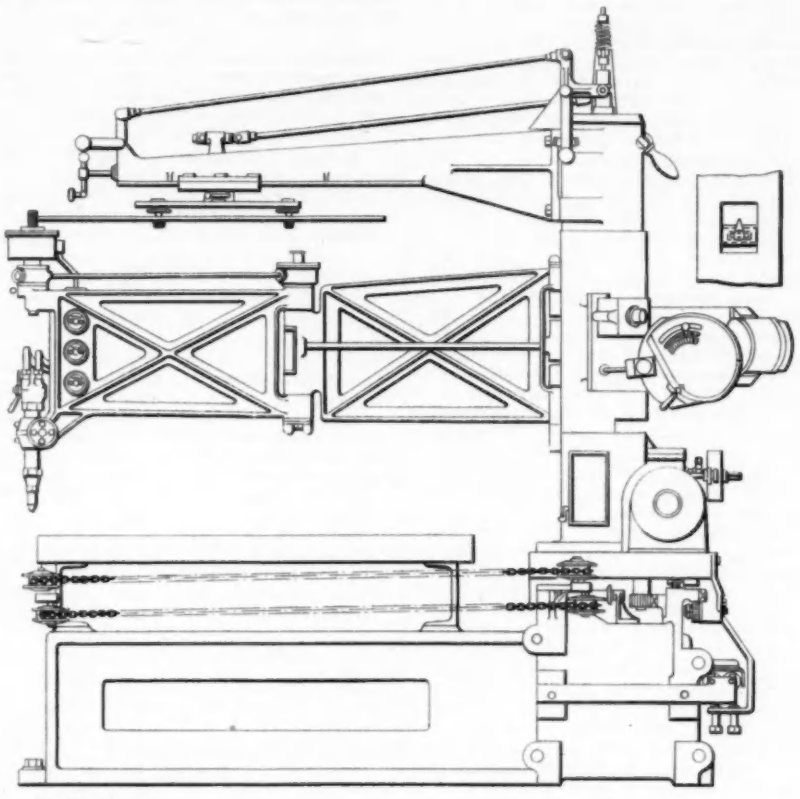


FIG. 33—OXYGEN CUTTING MACHINE—BRITISH OXYGEN CO.

firm has already been described in our columns, and so needs no further reference here; but the new small model should be mentioned. It has an area 20in. long and will make a straight cut up to 3ft. 6in. long. In order to simplify the mechanism the usual change-speed gear-box of the larger machines has been omitted; but speed changes can be effected by substituting pairs of gear wheels ready mounted in convenient little cases. Another new machine on this stand was a simplified edition of that just described, in which hand operation takes the place of automatic control.

THE METROPOLITAN FUEL COMPANY, LTD.

The stand of the Metropolitan Fuel Company, Ltd., 43, Johnson-street, Westminster, was noteworthy on account of several applications of the surface combustion principle. Among them there was an erection, which, more or less, resembled a fountain, with incandescent surfaces in the place of water, the resultant effect being, especially in the atmosphere of

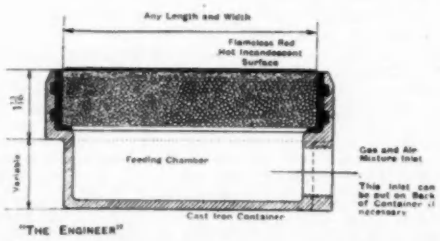


FIG. 34—FURNACE WITH COX COMBUSTOR—METROPOLITAN FUEL CO.

the Fair, very comforting. There were also some furnaces heated by means of the Cox Combustor, of which we give a sectional diagram in Fig. 34. We have in the past described in some detail the principle of surface combustion developed by Professor Bone and Mr. Cox, so that it is hardly necessary to enlarge upon the subject here; but it is appropriate to mention the fact that the actual burner surface is now made of a material which can be moulded into shape in almost any dimensions. This refractory material is made of graded granules which gradually diminish in size as the burning face of the block is approached.

JOHN HANDS AND SONS, LTD.

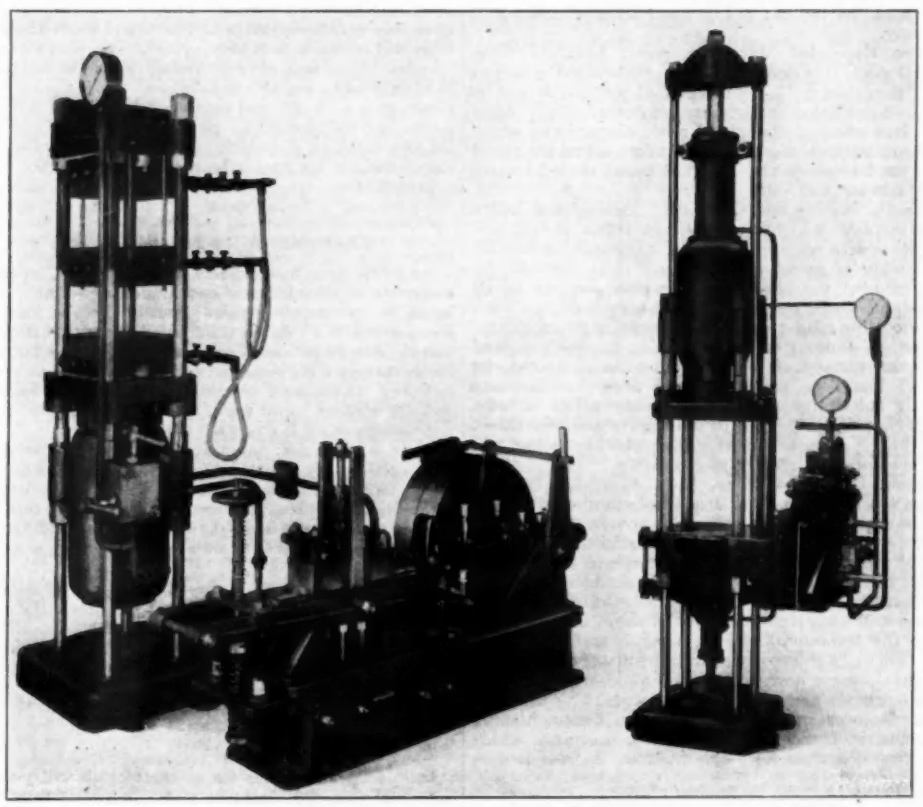
Among the various power presses on the stand of John Hands and Sons, Ltd., one of the most novel was the overhung percussion screw press shown in Fig. 35. The standard machine is equipped with fast and loose pulleys for belt driving, but that shown at the Fair was driven by an electric motor carried on brackets on the side of the frame, and a roller chain to the top shaft, enclosed in a guard. The general construction of the machine is similar to that of the press by the same firm, which was described in THE ENGINEER of February 24th, 1928; but the new example is of rather smaller dimensions, while it is controlled by double hand levers, so that the attendant must use both hands and consequently cannot get one trapped in the mechanism. The general dimensions of the machine are as follows:—Maximum pressure at bottom of stroke 20 tons; stroke of slide, 6in.; diameter of screw, 2¾in.; approximate net weight, 24 cwt.; height under slide guides, 10in.; maximum height, slide up, 14in.; size of table overall, *l* to *r*, *f* to *b*, 18in. by 10¼in.; diameter and width of driving pulleys, 10in. by 2¾in.; revolutions per minute of driving pulleys, 220; maximum strokes of slide per minute, 25; horse-power of motor required, 2; height above floor level, 99in.; floor

FIG. 35—PERCUSSION SCREW PRESS—HANDS

space required, *l* to *r*, *f* to *b*, 58in. by 42in.; centre of slide to back, 6½in.

BRADLEY AND TURTON, LTD.

There were two rather ingenious hydraulic pumps on the stand of Bradley and Turton, Ltd., 85, Great Hampton-street, Birmingham. One of them, which we illustrate in Fig. 36, is for power driving and is intended to eliminate the necessity for an accumulator. The main driving shaft runs continuously and works a connecting-rod which oscillates a curved link like that of a Stephenson reversing gear. This link, in



FIGS. 36 AND 37—VARIABLE-STROKE PUMP AND MOULDING PRESS—BRADLEY AND TURTON

turn, drives the pump rams. The pivot of the link is carried by two long levers running along either side of the machine and hinged about the crank shaft. These levers are weighted, according to the desired working pressure, and are supported at their free ends

by a small hydraulic ram communicating with the delivery side of the pump. If the pressure at the delivery rises above the normal this ram lifts the side levers and reduces the rate of delivery by shortening the leverage of the connecting-rod on the slotted link and consequently reducing the stroke of the pump rams. In this way the delivery is automatically controlled from full load to no load according to the demand made upon the pump.

The second pump mentioned above is for hand operation and gives two rates of flow, one at low pressure for filling up purposes and the other at a high pressure for finishing pressing operations. For low-pressure work the pump is worked as an ordinary single-ram machine, but when a high pressure is required a second ram of slightly smaller diameter is also brought into operation. The two rams, then, work in opposition and the effective area of the rams is the difference of their areas, and very high pressures can be attained without great manual exertion.

The press which we illustrate in Fig. 37 is intended for such purposes as moulding Bakelite and similar materials. It is fitted with an overhead tank for filling the ram cylinder by gravity, and a simple non-return valve for shutting off this supply of water when the finishing pressure is introduced. This valve is worked automatically by the rise and fall of the press.

Other Exhibitors.

Among the other firms exhibiting at the Fair there were A. E. Westwood, Ltd., of 65, New-street, Birmingham, which showed the "Oil Gun," or pump-operated oiler which we have already described. It had, however, on this occasion been fitted up to demonstrate the fact that it can be used to pump such viscous material as Stauffer grease.

G. A. Harvey and Co. (London), Ltd., of Woolwich-road, London, S.E. 7, had a big display of perforated and woven material in various metals, and some specimens to demonstrate the heavier classes of work now carried out in the shops. These specimens included a dished boiler end, 9ft. in diameter by 1¼in. thick, and some plating for large oil storage tanks.

Henry Wiggin and Co., Ltd., of Wiggin-street, Birmingham, exhibited among a number of other classes of wire, some resistance wires made of a 80–20 nickel-chromium alloy, having the following characteristics :—Specific resistance, 103 microhms per cubic centimetre ; temperature coefficient, 20 deg. to 500 deg. Cent. = 0·00009792 ; temperature coefficient, 500 deg. to 1000 deg. Cent.; tensile strength, 59 tons per square inch ; melting point, 1375 deg. Cent.; specific heat, 0·106 ; specific gravity, 8·35 ; coefficient of expansion, 20 deg. to 100 deg. Cent. = 0·0000125.

Rylands Brothers, Ltd., of Warrington, made a special display of steel wire galvanised by the Crapo hot-dip process. This process is claimed to give a much more adherent coating than the ordinary system, and we found by testing some samples that this claim is justified. A piece of wire could, for instance, be twisted round itself without flaking or peeling.

The Expanded Metal Company, Ltd., of West Hartlepool, was demonstrating practically the merits of "Servarising" as a method of protecting metals against oxidation at high temperatures. The process involves coating the metal with aluminium, which penetrates the surface. A muffle furnace on the stand was used to show how resistant metal coated in this way can be produced.

Earle, Bourne and Co., Ltd., Birmingham, had a fine display of yellow metal rods, tubes, strips, &c., together with some specimens of "Baronia," a bronze-like alloy of secret composition. It is specially recommended for condenser tubes on account of its resistance to corrosion, and for heavy bearings, such as those for rolling mills, on account of its strength.

Arthur Balfour and Co., Ltd., of Sheffield, showed a great variety of tool steels and a new material which has been named "Collet Steel," on account of its suitability for making spring collet chucks. It is supplied in the bar in the heat-treated condition, so that it does not need subsequent hardening, but is, nevertheless, readily machineable.

Thos. Firth and Sons. Ltd., Sheffield, had, of course, a most imposing display of stainless steel and other special steels, but the most novel exhibit was a new form of circular saw with inserted teeth of high-speed steel. The teeth are cut, several together, in short segments and are riveted to a mild steel centre.

Charles D. Phillips, Ltd., of Newport, Mon., is a name well known throughout the world in connection with the *Monthly Machinery Register*, and at the Fair the firm had a stand on which the utility of the *Register*, in introducing new and second-hand machinery to possible customers, was demonstrated. This firm also manufactures mortar mills, friction hoists, hauling engines and electric haulages, concerning which illustrated leaflets were exhibited on the stand.

The former Cambrian Railway having been absorbed by the Great Western has made it possible to connect the latter company's branch line between Oswestry and its main line at Gobowen with the main line of the Cambrian section. The Great Western station has therefore been closed and through running is now possible between Birkenhead and Aberystwyth.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE LANGUAGE QUESTION.

Sir,—The leading article on "The Language Question" in the current issue of The Engineer hits upon a most important subject for engineers, probably more so than for any other professional class.

Our national neglect of the language question has long been proverbial, so long indeed that the shibboleth probably outlives the truth. There are to-day, I believe, thousands of good linguists stuck away in offices and in jobs where their talent has no opportunity, and hidden even from their colleagues all around.

This comes from the contempt shown for foreigners and their languages which in the past has been characteristic of ourselves as a nation. The expressions "Dago," "Chink," "Squarehead," or "Yank," in those you have the world outside ourselves. It has been my lot to live abroad among foreigners for years, and I have command of ten languages ; yet the men who work alongside of me do not know it, they are not interested and do not care. This leads to some very amusing experiences at times. They all, foreigners as well, assume because you are a Britisher, English is the only language you can understand, and they act accordingly. This is totally wrong, and there is no reason whatever why we should lag behind other nations in this respect ; all it needs is application to the study and determination. There are innumerable facilities now which did not formerly exist for easily acquiring languages. A monthly journal, the *Linguist and Traveller*, is devoted to the teaching of five languages. Broadcasting and the B.B.C. journal, the *Listener*, give lessons in French and Italian. The gramophone records are also available. Surely we are already awakening to the importance of the subject. The return for the trouble taken is really beyond measure. Those cold, stiff and unintelligible strangers warm up into human beings the moment they hear their language spoken. It is a sure key to their hearts, and, apart from the business aspect, it makes life so much more interesting. As a cure for boredom and a certain road to happiness, as a mental tonic and an aid to keeping young, alert, and fit, I can fully recommend languages. The modern "best sellers" would not find so ready a market if the young could be brought to realise the pleasures which this key opens out for them. The "blue bird" is here, right in their own garden, for them to grasp any time they wish. May I relate one little human incident showing the value of languages ?

I was waiting for a train in a most miserable railway station in the heart of our Black Country in the Midlands. Up to that time I had not met any Germans in this country since the war. On the platform I met a stranger, who remarked, "This is worse than Siberia." I naturally asked if he was a Russian, but he told me he was German. We then spoke in German, and I tried to evade all subjects concerning the late war, but he would persist in asking "If I had seen any Zeps." I replied that I had not been near when they were brought down. However, I showed friendliness and offered to help him, giving him my card for that purpose. Some time after he availed himself of this, and in a small way I was able to help him. His gratitude was shown on a postcard, and paid a most profound compliment ; the postcard gave a picture of our war memorial, the Cenotaph, at Whitehall. Could any language speak the meaning of the human heart more than this ?.

Cardiff, March 1st. E. F. M.

HIGH-PRESSURE LOCOMOTIVES.

Sir,—The letter by "A Forty Years' Recorder," in The Engineer for March 1st, makes interesting reading, and certainly the double-pressure locomotive is a curious arrangement, but I do not think it is fair to say it is comparable with an ordinary compound supplying part of the steam through a reducing valve direct to the low-pressure cylinders. In the latter case loss is incurred in reducing the pressure without useful work, whereas in the former the low-pressure steam is generated at that pressure.

There is one point, however, that I would stress, and that is the futility of judging the commercial efficiency of a locomotive by its steam rate and not by its coal rate. After all, it is the coal that costs the money, and there is no fixed proportion between the two quantities for different types of engines, as will be seen by the following table of recent trials results :—

	Steam, lb. per D.B.H.P. hr.	Coal, lb. per D.B.H.P. hr.
P.L.M. 4–6–2 compound, 1913 trials	21·6	3·02
G.W.R. "Caldicot Castle," 1924	28·1	2·98
L.M.S. "Royal Scot," 1927 ..	24·5	2·96
Schmidt-Henschel, 1927.. ..	18·75	2·32
New York Central 4–6–4, 1927	24·5	2·93
Winterthur, 880 lb., 1928 ..	19·3	2·55

In this table the rates are averages of all the runs in each trial with the exception of one or two runs of the L.M.S. "Royal Scot," which were with stopping trains or were otherwise unsuitable for inclusion and one run of the Winterthur locomotive which was with a goods train. I think this is rather fairer than taking the very best run of each locomotive, which may have been influenced by exceptional circumstances. The coal rate is corrected for a coal value of 14,000 B.Th.U. per pound, the actual coal values were given in all cases except that of the P.L.M., and in this case it is assumed at 12,700 B.Th.U. per pound which should be about right.

It will be seen that while the P.L.M., G.W.R., L.M.S., and New York Central coal figures are all very nearly the same, the steam figures vary from 21·6 lb. to 28·1 lb. per D.B.H.P. hour ; it would seem that the size of the superheater is the cause of the discrepancy, and this is quite understandable ; but it is rather remarkable that it averages out so closely. What one gains in engine efficiency is lost in boiler evaporation and *vice versâ*. It will be seen that the Winterthur locomotive is not so good as the Schmidt-Henschel, either in the engine or boiler.

I am very interested in the reference to a L. and N.W.R. triple-expansion locomotive with 700 lb. pressure which your correspondent says was built about 1880. I have never seen any previous mention of such a high-pressure locomotive, though it is well known that Mr. Webb did build a triple-expansion machine in 1878, and, according to the late Mr. Ahrons, this had a cylinder ratio of about 1 to 4½ and a pressure of 200 lb. May we have further particulars of this 700 lb. locomotive ?*

Cookham Dean, March 5th. C. M. Keiller.

Sir,—Referring to the extremely interesting letter on "High-pressure Locomotives," by "A Forty Years' Recorder," in your issue of March 1st, 1929, it is a matter for gratification that the inventions and labours of Mr. Jacob Perkins, my great-grandfather, in connection with the use of steam at very high pressures—900 lb. to 1000 lb. per square inch—are now being appreciated. The high-pressure locomotive, mentioned in the communication, for the L. and N.W. Railway about 1880 evidently refers to a design submitted by my late father, Mr. Loftus Perkins, to Mr. F. W. Webb, at that time locomotive superintendent at Crewe Works.

The progress of the high-pressure steam locomotive now being constructed for the L.M. and S. Railway will, without doubt, be followed with the greatest interest by all locomotive engineers. May it prove eminently successful.

London, March 4th. Loftus Patton Perkins.

CANALS AND TRANSPORT.

Sir,—I note the letter by Mr. Good in your issue of the 22nd ultimo, in which he condemns canals entirely, as regards this country at all events.

He assumes to write with authority, as he has been actually reared on a canal barge. I suppose that these canal barges would be the old horse-drawn ones, in which case, of course, I can understand his wholesale condemnation.

If modern methods had been used to draw these barges, I am sure he would have a very different tale to tell, even with the admitted handicap in this country of the large number of locks per mile. The universal adoption of mechanical haulage to barges, instead of horse haulage, would unquestionably alter the whole aspect as to the efficient utilisation or otherwise of the canals in this country. J. W. White.

Widnes, March 1st.

THE CHANNEL TUNNEL.

Sir,—Replying to the footnote appended to my letter in your last issue, may I say that my estimate of increased traffic on the proposed London and Paris Railway is solely due to the improved facilities which will be available, consisting of (1) the elimination of the sea crossing, with its uncertainty for good or evil ; (2) a 60 per cent. reduction in the transit time now occupied between both London and Boulogne, for Central and Northern Europe, and London and Paris ; and (3) a 33 per cent. reduction in the average fare charged by the short sea routes between London and the two cities named. The cumulative effect of these advantages on the cross-Channel traffic now existing must needs be large, and may be far larger than our present estimates. William Collard.

London, March 4th.

The Iron and Steel Institute.—The Council of the Iron and Steel Institute has this year awarded the Bessemer Gold Medal of the Institute to the Honourable Sir Charles A. Parsons, K.C.B., O.M., F.R.S. The award is made in recognition of his distinguished services in advancing the science of engineering as applied to the manufacture of iron and steel. The Williams Prize of the Iron and Steel Institute, which was founded by Mr. Illtyd Williams on his retirement in 1926 for the encouragement of papers of a practical character, has been awarded to the two papers, "Blast-furnace Practice in Natal," by Messrs. J. E. Holgate and R. R. F. Walton ; and "The New Plant of the Appleby Iron Company, Ltd.," by Messrs. A. Crooke and T. Thomson. The prize, which is of the total value of 100 guineas, has been awarded in equal portions to the authors of these two papers.

Burst Water Mains.—At its meeting on Friday last, March 1st, the Council of the Institution of Water Engineers appointed a committee to investigate the matter of burst water mains. The committee will consist of the following :—Mr. S. C. Chapman, M. Inst. C.E. (Torquay), the President of the Institution ; Mr. F. W. Macaulay, M. Inst. C.E. (Birmingham), the President-elect of the Institution ; Mr. H. E. Stilgoe, M. Inst. C.E. (Metropolitan Water Board), a Vice-President ; Mr. A. B. E. Blackburn, M. Inst. C.E. (Sunderland and South Shields), a Past-President ; Mr. Fred. J. Dixon, M. Inst. C.E., M.I. Mech. E. (South Staffs.), a Past-President ; Lieut.-Col. J. R. Davidson, M. Inst. C.E. (Liverpool) ; and Mr. J. K. Swales, M. Inst. C.E. (Bolton). The Secretary is Mr. A. T. Hobbs, A.M. Inst. C.E., Institution of Water Engineers, Parliament Mansions, Victoria-street, S.W. 1. The first meeting of the committee will take place on Friday, March the 15th.

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* See The Engineer, November 26th, 1926.—Ed. The E.

Railway and Road Matters.

As far as we can see, no British railway officer's name appears in the New Year Honours issued on March 1st. Mr. C. W. Hurcomb, the Permanent Secretary to the Ministry of Transport, and Brigadier-General H. O. Mance receive the order of K.B.E., whilst in the Indian list there is the K.C.I.E. for Sir Clement Hindley, the late Chief Commissioner of Railways, and the C.I.E. for Mr. J. M. D. Wrench, the Chief Mechanical Engineer, Great Indian Peninsula Railway.

THE proposal of a distinguished body of signatories, on behalf of the Royal Astronomical Society, as to the adoption of the twenty-four-hour notation was mentioned in this column on December 21st. Ventilation of the subject in *The Times* has not brought forth any serious opposition, and now it is announced that Lord Lamington proposes, on an early date, to ask the Government whether it will consult the railway companies as to the desirability of introducing the twenty-four-hour system.

IT may be remembered that Parliament, when granting road powers to the railway companies, excluded the Metropolitan. That company has, however, secured the desired end by indirect means. At the annual meeting of the company on February 21st, the chairman announced that in 1926 Parliament granted the Metropolitan Railway Company certain powers of investment, which had enabled the directors to make arrangements with an outside company that will put the railway in an equally good position to exercise some control over the operations of competing omnibus services.

WE hear that one unit of the oil-electric locomotive of the Canadian National Railways, which has Beardmore high-speed engines, has already passed through very successful trials on the road. The single unit has hauled freight trains of 2000 tons at 25 miles per hour, and express passenger trains of 650 tons at over 60 miles per hour. The fuel consumption is working out at about 8½ lb. per 1000-ton miles. The complete engine should take approximately twice the weight of freight train and will be handled by one crew. The engine has 12in. by 12in. cylinders, and runs at 800 r.p.m., but there is, we are informed, little vibration, and the whole locomotive rides well.

OPPONENTS of the State ownership of railways will be pleased to hear that Mr. Herbert Hoover, the new President of the United States, is enlisted on their side. Giving evidence before the Inter-State Commerce Commission, as to the future of the railways of the United States, in the spring of 1922, Mr. Hoover said: "No one with a week's observation of Government railways abroad, or with Government operation of industry in the United States, will contend that our [the United States] railways could ever be operated as intelligently or as efficiently by the Government as through the initiative of private individuals. Moreover, the welfare of its multitude of workers will be far worse under Government operation."

THE coroner's inquest into the death of the three men who were killed at Bispham, near Blackpool, on January 6th, was concluded on February 13th. As reported in this column on January 18th, a light girder bridge was being erected across the railway for the convenience of a private firm. The work was being done independently of the railway company, which, apparently, was interested only in the safety of the trains during erection. Whilst a girder was being placed in position a train passed, and the girder failed at that moment, causing three men working on it to be killed or fatally injured. From the evidence given at the adjourned inquest, it appears that the steel was faulty, and a verdict to that effect was returned.

THE International Railway Congress will be held in Madrid next year. According to Reuter, the International Transport Federation is taking steps to ensure that representatives of the men are included in the delegates sent by the various Governments. It is said that as the Railway Congress deals with technical and other questions which have more or less a bearing on the interests of the staff, some kind of representation of the men is becoming urgently necessary. It should, we think, be added that, independently of the delegates sent by railway companies, the various Governments, in return for their subscriptions to the Congress funds, nominate representatives, and it is, we assume, the suggestion that practical railwaymen should be included amongst them.

THE evidence given at the adjourned coroner's inquest on February 25th, into the death on the 12th idem, of the two enginemen on the down Scottish express that ran into a standing goods train near Doe Hill, showed that it was brought about by the signalman reversing all four levers which he had pulled to set back the goods train instead of restoring only three. Consequently, when the goods train arrived on the down passenger line and again moved forward, it remained on the down passenger, or facing, road instead of crossing on to the up passenger line. A signal is provided to safeguard this movement, but the train did not set back sufficiently far to be in the rear of it, otherwise the signalman, had he attempted to clear it, would have discovered his error. A verdict of "Accidental death" was returned.

THE final portion of the Southern Railway Company's electrification scheme was opened for traffic on Sunday, March 3rd. The additional lines now provided for electrical traction are those between Streatham and Epsom, *viâ* Mitcham Junction; Streatham Junction and Wimbledon; Herne Hill and Tulse Hill; and Norwood Junction and Beckenham Junction. Two new services of trains have been established, *viz.*, between Holborn Viaduct and Wimbledon and between Effingham Junction and London Bridge. The former Epsom Junction Station has been rebuilt and enlarged, and now serves the Sutton and Raynes Park lines instead of only the latter. Epsom Town Station, on the Sutton line, has been closed. The annual report for 1928 of the Southern Railway budgets a proposed expenditure this year of £191,000 from capital account for electrification, which suggests further extensions. As all the lines in the London area, except the very minor Wimbledon and Croydon, have now been converted, it would seem as though the line throughout to Brighton may now soon be dealt with.

Notes and Memoranda.

A NEW solvent for cellulose has been put upon the market by a New York firm. It is ethylene glycol mono methyl ether, and is said to have the lowest boiling point of all the available glycol ethers.

SOME tests carried out for the American Ceramic Society emphasise the fact that while in the majority of cases defects which develop in lime plaster are noticeable at the end of a year, certain impurities may cause defects which are only apparent after several years' ageing.

IN one of the most recently erected buildings in Philadelphia there are twenty lifts. Of them, half run at a speed of 700ft. per minute, up to the seventeenth floor. The remainder work at a speed of 800ft. per minute, and carry "express" passengers up to the twenty-eighth storey.

THE present rate of consumption of raw material of the wood distillation plants of Poland is some 100,000 cubic metres of deciduous wood a year. From this material there are recovered 10,000 tons of charcoal, 1000 tons of pitch, 500 of methyl alcohol, and 2400 tons of calcium acetate.

THE official report on the collapse of the furnaces of the boiler on board a small coasting steamer, which has just been issued, mentions the fact that scale ranging from ⅛in. up to ¼in. was found on the heating surfaces. The Engineer Surveyor-in-Chief remarks that the case is "an illustration of the hard conditions under which the boilers of many of these small home trade vessels are run."

ACCORDING to Mr. A. H. Marshall, of Hartford, Connecticut, the steam cooling, or constant-temperature running of motor car engines is more desirable than the present-day water-cooling system. Some day a motor will be designed to obtain the largest number of the advantages offered by the constant-temperature engine. The change will be in the water jacket and the radiator, with the use of a much smaller pump; the appearance of the car will remain unaltered.

THE characteristics of bentonite as an adsorbent, emulsifier, or peptiser, should make it available in the manufacture of soaps and detergents, horticultural sprays, animal dips, insecticides, fungicides, paints, inks, waterproofing plasters and dynamite; in the de-inking of printed papers, the refining of oils and fats and in the removal of water from petroleum. As a chemical reagent, bentonite should be of value as a water softener, as an aid to soil fertility, and in the treatment of molasses.

A RATHER unusual cause for the destruction by water hammer of a valve on a steamship is suggested in a recent official report. The pipe system seems to have been reasonably well planned, except that two stop valves were at the lower ends of their respective pipes. In the process of coaling the bunkers, the trim of the ship was changed and water which had accumulated in one of these pipes flowed into the other, and in passing caused a fatal explosion. Had it not been for the rolling of the ship, the accident might not have occurred.

ELEMENTS such as carbon, oxygen, and nitrogen are soluble, according to Mr. T. D. Yensen, in alpha iron in minute quantities, occupying or passing through the interstitial spaces of the crystal lattice. On account of this intimate relationship, they exert considerable influence on the properties of iron, and until we can simultaneously remove, or keep, out these interstitial impurities we shall have no direct evidence as to the presence or absence of allotropy in pure iron. Indirect evidence, however, obtained from iron-silicon-carbon alloys points to the possibility that pure iron may have no allotropic transformations.

IT would appear from some remarks made by Mr. L. L. Holliday, of the General Electric Company, that glazed windows are becoming effete. In concluding a paper for the *Journal* of the Franklin Institute, he says that a practice of washing windows less frequently than twice a year is uneconomical, excepting when the minimum intensity of illumination upon the work plane is maintained at less than 10 foot-candles. When determined merely by the cost of lighting, it appears from these results that for any type of standard building operating under average conditions, no appreciable expenditure for natural lighting equipment is justifiable when electric energy can be purchased as low as 1·4 cents per kilowatt-hour.

AT the United States Bureau of Mines some experiments have been made to determine the amount of incombustible material required in a mixture to prevent propagation of an explosion under standard propagation test conditions. It was found that 20 per cent. was sufficient for a coal whose ratio of volatile to total combustible was 0·15, but the quantity increased rapidly with increasing ratio and 61 per cent. was required with coals whose ratio was 0·23. Beyond the ratio of 0·40 there was a slow increase and 70 per cent. incombustible was required for coals of which the ratio was 0·50. It is felt in America that these limits are known with sufficient accuracy to justify applying them to any coal not tested in the experimental mine. Composition is one of six factors which influence the explosibility of coal dust, and a paper summarising the present knowledge of all six is in preparation for publication by the Bureau.

SOME experiments which have been made in America by the Bureau of Mines, suggest that the addition of barium oxide to the fluxing material of a blast-furnace is not justifiable. It is explained that a comparison of the desulphurising action of slags was made by holding contiguous layers of the molten slags and high sulphur metal in contact at temperatures from 1400 deg. to 1600 deg. Cent. Small streams of metal were also passed through layers of the various slags to assimilate the passage of globules of metal through the slag bath in the crucible of the blast-furnace. On account of the high molecular weight of barium oxide, it is only equivalent to about one-third its weight of calcium oxide as a base for fluxing silica. A replacement of about one-fourth the calcium oxide with barium oxide increased the rate of sulphur elimination. The cost of barium oxide necessary to replace this fraction of the calcium oxide in blast-furnace slag would, however, be prohibitive.

Miscellanea.

IT is proposed to build several new bridges across the Suchow Creek in Shanghai.

THE Johannesburg Municipality proposes to expend £81,500 on sewerage works.

THE antimony deposits at Lake George, New Brunswick, are to be developed by a newly formed company.

A FACTORY, said to have a capacity of 30,000 tons of soda ash a year, has been set to work at Tangkoo, China.

IT is anticipated that the low-temperature carbonisation plant at the Askern Colliery, near Doncaster, will be in working order this month.

BY means of adopting a scheme of pre-cast concrete piles a bridge 5 miles long across the James River, Newport News, was built in thirteen months.

THREE new tin-plate mills have been started by the Pencoed Company at Llwynhendy, and it is intended to add another three mills to the establishment.

IT is announced that Mr. Rees Jeffreys has arrived in South Africa with the object of consulting with the authorities there on road transportation problems.

THE Chinese Government proposes to expend between seven and eight million pounds sterling on the improvement of the Huai River and the Grand Canal.

AT an expenditure of about 6,000,000 dollars, a 250-ton paper mill and a 75-ton sulphite mill are being erected at Buckingham, Quebec. The power for the plants will be derived from the High Falls station of the MacLaren Company.

WORK on the dock extension scheme at Cape Town is progressing to such an extent that over 600ft. of the new breakwater were completed at the beginning of this year. It is anticipated that the work now authorised will be finished in about three years.

IT is noteworthy that while the contract for the construction of the recently completed Imperial Chemical house, at Millbank, London, called for a rate of progress of 14,000 square feet of floor space per week, the actual production amounted to 27,000 square feet as a maximum.

THERE has just been issued from H.M. Stationery Office the second part of the technical paper on the assay of coal for carbonisation purposes. The present paper gives further details of the considerations and experiments which led to the original design, together with the results of experience of over seven years' use of the apparatus at the Fuel Research Station and in the laboratories of the Physical and Chemical Survey of the National Coal Resources. It is thought that the information here set out will be of assistance to all users of the apparatus, and in particular to those using it for the examination of the more strongly swelling coals.

THE Alachua Tung Oil Company, organised by Benjamin Moore and Co., of New York, said to be one of the largest users of tung oil in the United States, has, according to *Chemicals* (New York), begun the operation of its new tung oil plant at Gainesville, Florida. Tung oil is used in the United States largely as a base for lacquers, high-grade varnishes or as a waterproofing element in electrical installations. It has been imported from China, to an annual value of 15,000,000 dollars, or about one-fifth of the value of total imports of paint oils. It is now predicted that Florida will soon be able to produce this supply. The new plant will operate in steady runs of twenty hours per day and at a capacity of 60 gallons of oil hourly.

IT is expected that the new bridge across the Umfolozi River, Natal, will shortly be completed. This bridge is 1650ft. in length in eleven 150ft. spans, and is the longest in the Union. Its cost is estimated at rather more than a quarter of a million sterling. The crossing of the Umfolozi at this point has been, says the *South African Engineer*, attended with difficulties, and on two occasions previous structures have been washed away. On this occasion a new site has been chosen, calling for a deviation of the railway and a tunnel through a hill, and it is hoped that the new structure, with its extra height, will be immune from floods. The roadway is carried on a series of cantilevers standing out from the main structure, which carries the railway track.

ACCORDING to Mr. E. Richie, an outstanding example of progress in industrial illumination is found in the conversion of the lighthouses and lightships of Britain which is now taking place. Three or four years ago the question was asked by the Engineer-in-Chief of Trinity House whether high-power gas-filled lamps could be produced which could be used in place of the existing arc lamps and other illuminants. Experimental work was immediately started, the principal problem being to produce a filament which would maintain the beam at its full brightness while it was visible, and then give place to absolute darkness, at the same time giving a compact focal source in order to avoid a split beam. After many months of experimental work, the difficulties were surmounted and a satisfactory lamp produced. Lamps complete with automatic lamp-changing gear have already been installed in the lighthouses at Burnham, Pendine, The Lizard, Hartland, and the Skerries.

THE demand for light machinery in China has called for the establishment of quite a number of foundries and ironworks in the new capital. At present there are sixteen ironworks and foundries in Nanking City and Hsiakwan, some of them being modernised blacksmith's shops. Of sixteen works, four are operating on a comparatively larger scale, each employing fifty to sixty hands, and possessing oil engines, and in some cases a foundry shop. The number of workmen in the other works ranges from ten to thirty. The simple machines and machine parts turned out by these establishments are used chiefly in Nanking, with a small balance for export to neighbouring market towns. The output consists chiefly of rice-polishing machines, lithographic printing machines, pumps, cotton scutchers, hosiery knitting machines, noodle-cutting machines, &c. At some foundries stoves and brass and iron railings are also turned out. The raw material, pig iron, used to be imported from Japan, but now Nanking ironworks much prefer to import from British sources.

P. AND O. TURBO-ELECTRIC LINER "VICEROY OF INDIA"—MAIN PROPELLING AND AUXILIARY MACHINERY

(For description see page 272)

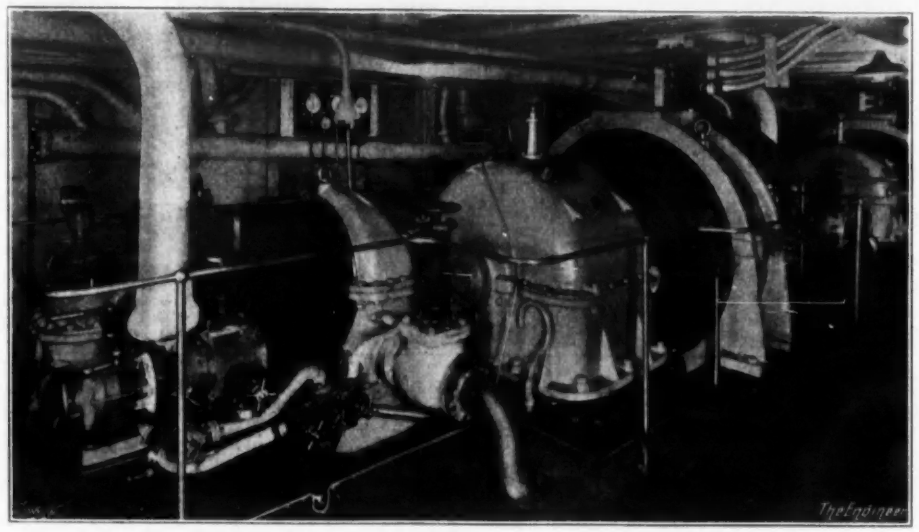

FIG. 6—500 kW AUXILIARY TURBO-GENERATOR SETS

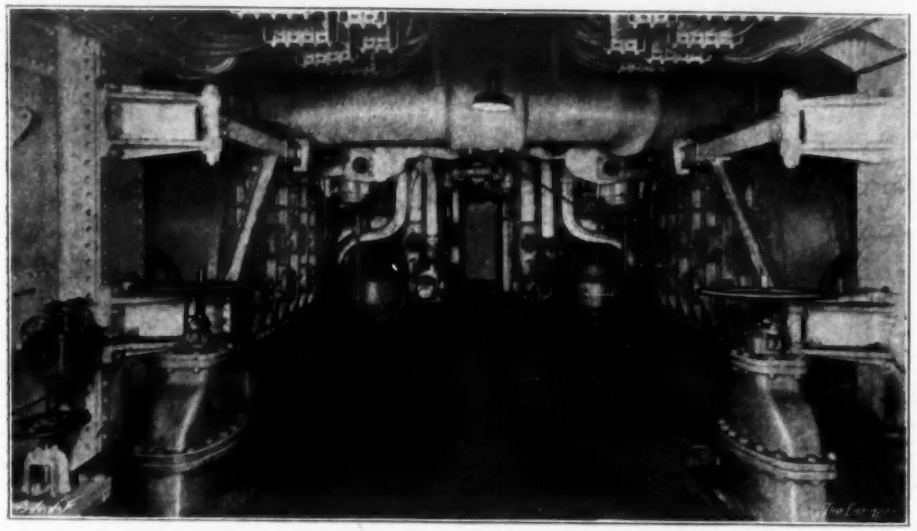

FIG. 7—MAIN CONDENSERS WITH FEED AND EXTRACTION PUMPS

FIG. 8—8500 S.H.P. MAIN PROPELLING MOTOR LOOKING AFT

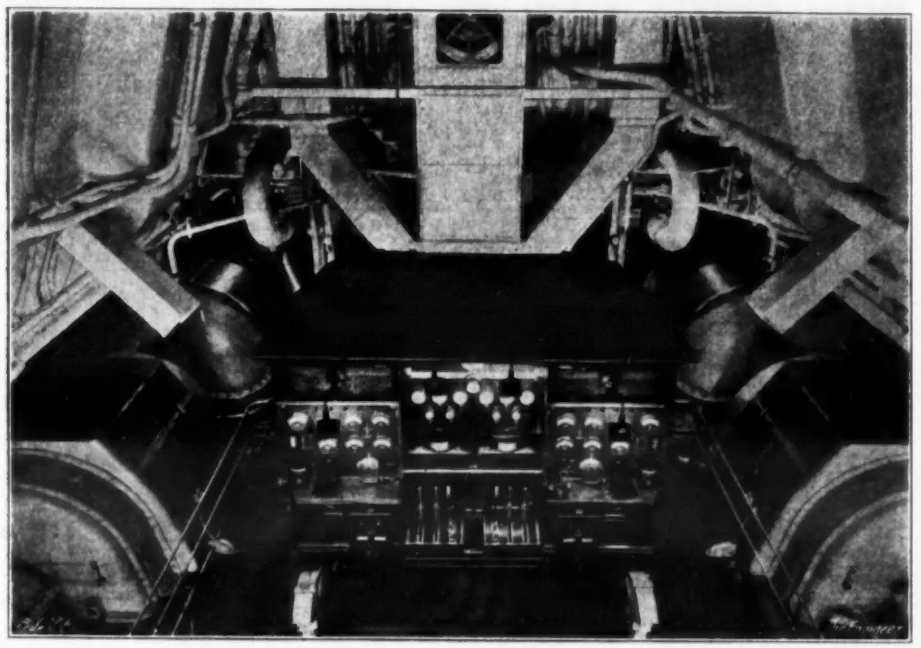

FIG. 9—MAIN ENGINE-ROOM LOOKING FORWARD

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THE ENGINEER.

MARCH 8, 1929.

The Efficiency of a Condenser

THERE is probably no more hard-worked term in engineering than the word "efficiency." It connotes a characteristic always striven for by designers, yet one which it is not always easy to define. The difficulty is especially great when a machine or apparatus is performing several functions at once. In the case of condensing plant, for example, nobody would hesitate to say that some condensers were more efficient than others, yet few would be ready to say exactly what they meant by such a statement. When the word efficiency is used in a quantitive sense it signifies the ratio which the actual performance bears to some ideal. The ideal is that which an absolutely perfect machine would attain. But when one tries to imagine an absolutely perfect condenser the trouble begins. The primary duty of a condenser is to condense steam, but one cannot say the better the condenser the more it will condense without taking its size into account. The criterion then becomes the rate at which steam can be condensed per square foot of cooling surface, or, to put it more precisely, the coefficient of heat transmission which can be attained. But what would be the coefficient of heat transmission of a perfect condenser? It would obviously be infinite, and therefore all actual performances would be equally good or equally bad with respect to it. One can certainly claim that a condenser with a coefficient of, say, 800 is twice as good as one with a coefficient of 400; but the comparison has no reference to any ideal of performance and therefore fails to indicate the real efficiency of either of the condensers.

Another point of view may be taken. Condensing plant is installed to create a vacuum, so that it is reasonable to contend that efficiency should be measured by the ratio of the vacuum obtained to that which is theoretically possible. But definiteness is not yet secured. The vacuum theoretically possible may be regarded as that limited by the vapour pressure of the condensate only. A perfect condenser would certainly produce a vacuum corresponding to the temperature of the condensate, for, by hypothesis, there would be no air present nor any pressure drop across the condenser tubes. Hence we have an ideal performance with which the actual performance can be compared. Such a comparison is indeed commonly made, the ratio of the actual to the ideal vacuum being called the "vacuum efficiency." It has the merit of being expressible as a percentage; but, on the other hand, the figure obtainable does not refer exclusively to the condenser, but will vary with the effectiveness of the apparatus used for air extraction. On the Continent it is common to express the vacuum itself as a percentage, namely, the ratio of the negative pressure in the condenser to the atmospheric pressure without. This percentage, of course, has nothing to do with efficiency, being merely an alternative to stating the vacuum in terms of absolute pressure or of inches of mercury. The "vacuum efficiency" as defined above does not take into account in any way directly either the quantity or the temperature of the circulating water. It is, however, evident that the merits of a condenser cannot be appraised without some reference to the cooling water. Of two condensers maintaining equal vacuum for the same quantity of steam dealt with, that one will be the better which makes the less demand on the circulating water system. This leads to another point of view. A condenser may be regarded as an apparatus for extracting heat from steam, and the heat extraction process will clearly be the more effective the less the temperature difference required to maintain it. This is not quite the same thing as saying that the coefficient of heat transference must be high, for the latter statement alone indicates no limit as to what is possible. There is, nevertheless, a limiting condition with regard to heat extraction, namely, the fact that the temperature of the outgoing circulating water can never be higher than that of the incoming steam. If the perfect condenser be regarded as one which would perform a given duty with the theoretical minimum of circulating water, then perfection would be attained if the water reached the temperature of the incoming steam, for every pound of water would thus be carrying away as much heat as it could possibly absorb. This way of looking at the matter has led to a definition of condenser efficiency as the ratio between the two temperatures in question. The definition, however, has no universal meaning unless the absolute temperatures are taken, for otherwise the ratio depends on the scale of the thermometer used. The usual difference between the temperature of the outgoing water and the incoming steam in land practice is from 8 deg. to 12 deg. Fah., giving a ratio of from 98·7 to 97·8 in the case of a condenser working with a vacuum of 28in. and from 98·5 to 97·8 with a vacuum of 29in. These figures are all too near together to be of much use in comparing condensers, while to claim an efficiency of over 98 per cent. under very ordinary conditions is to cast suspicion on the validity of this method of computing the efficiency. Other methods might be suggested, as, for example, the ratio of the power absorbed by the auxiliaries to the heat removed from the steam, but this does not get any nearer the root of the problem. What is wanted is some way of comparing the performance of an actual condenser with that of a perfect one, taking into account simultaneously all the features that such a comparison involves. If a condenser absorbed energy in doing work, or if it converted one form of energy into another, the definition of its efficiency would be easy. But it does none of these things, being merely a heat transmission apparatus. This fact alone does not cause the difficulty. A boiler is also merely a heat transmission apparatus, yet its efficiency can be simply stated as ratio of the heat entering the water to that supplied to the furnace. In any condenser the whole of the latent heat of the entering steam is always taken up by the cooling water, so that, judged by the same standard as a boiler, the efficiency of a condenser, whether a good, bad, or indifferent one, would always be 100 per cent. The analogy, therefore, obviously does not hold.

Indeed, no analogy seems helpful, for a condensing plant is *sui generis*. Yet it is so important a piece of apparatus in steam engineering that some way of appraising its merits as a whole is certainly needed. If a comparison with a perfect condenser is impossible on account of the impracticability of defining a perfect condenser, then the word efficiency in connection with condensing plant can have no quantitative meaning. We must therefore fall back on a comparison between actual plants and limit our aspirations to saying how much better one is than another without reference to any ideal plant. For this purpose it would seem that a "figure of merit" is needed which would serve as

a numerical expression of the general goodness of any particular condensing plant. How such a figure of merit could be computed is a matter which could not be settled very easily. It would obviously have to take into account the coefficient of heat transmission, the rise in temperature of the circulating water, the under-cooling of the condensate, the nearness of the actual to the possible vacuum, and the power required for auxiliaries, while other characteristics, such, for example, as the weight for a given duty, might also be included with advantage. Any formula combining all these variables in such a way as to furnish a single figure of merit would, of its nature, be an arbitrary one, but if wisely chosen it would be none the less useful. It would, at any rate, afford a means of answering the question—an apparently unanswerable one at present—as to how much better one condensing plant is than another.

Automatic Couplings on Continental Railways

THE technical section of the International Labour Bureau at Geneva has been making strenuous efforts to enforce the general adoption of automatic couplings on the continental railways. At its meeting last year a resolution was passed inviting the International Railway Union to make a thorough investigation into this matter and to issue a report as soon as possible, a limit of two years being specified. At the same time it was proposed to appoint a Commission with representatives of the various Governments, of the railway companies, and railwaymen. Since then the International Labour Bureau has been collecting information concerning the use of automatic couplings, and it has recently published the results obtained with such couplings in Japan. In that report it is stated that in 1926 there was a reduction of 16 per cent. in the number of men employed for the coupling of coaches and trucks, that the breakages of couplings had diminished by 68 per cent. as compared with those of 1924, and that there were no fatal coupling accidents, while casualties were reduced by more than 80 per cent. Moreover, it is claimed that the use of automatic couplings permits of the running of heavier trains. These figures are impressive, but they apply to a special case.

While the International Labour Bureau is endeavouring to hasten the general adoption of such devices, similar attempts have been made in the French Chamber of Deputies, where the Minister of Public Works was obliged to say that no compulsory measure could be taken with regard to automatic couplings until the programme for equipping goods trains with continuous brakes had been completed. The cost of doing both things simultaneously would be far too heavy. Although automatic couplings are being used and are giving satisfactory results under special conditions, there are nevertheless many difficulties in the way of securing their adoption on all the continental railways. They must be interchangeable in the same way as the continuous brakes. Trains on the Continent are often made up with coaches from the different foreign railway systems, and protracted negotiations, trials and modifications of apparatus are inevitable. This interchangeability of couplings raises a serious problem. It is easy for countries like Japan, which have not an exchange of rolling stock with foreign lines, to adopt a type of coupling which will satisfy many of the conditions required, but on the Continent many years must elapse before the universal adoption of automatic couplings comes anywhere near realisation. Not a single design, which is acknowledged by all the parties concerned to be quite satisfactory, has yet been found. The Boirault coupling has been used on the Paris suburban electric trains of the State railways since 1924. For years past all the known types of automatic couplings have been tested in service, quite a considerable number of coaches having been equipped by the State railways for the purpose, but there is no question yet of adopting any of them permanently. The couplings may be made quite secure, and they are effective when coupled up under shock, but some of them sometimes fail to connect under pressure, such as may happen when coaches are slowly pushed together when shunting. The French State Railways have probably acquired a particularly wide knowledge of the practical character of these devices as the result of their long series of trials, and the Compagnie du Nord is building an all-metal train with automatic couplings which, it is expected, will undergo trials at an early date.

It is doubtful whether the International Labour Bureau can do much more to hasten the adoption of automatic couplings than is already being done by the continental railways. Automatic couplings cannot be forced upon the railway companies until they are prepared for them They will come in time, when the companies are assured that they are perfectly reliable and satisfactory, and are convinced that there is an urgent need of them. There are many who advocate a retention of the existing types of couplings, and affirm that their danger is greatly exaggerated by including in the statistics of accidents those that have happened to men who are not engaged in the coupling and uncoupling of wagons. A complete inquiry is now being made into the accidents arising out of those operations on continental railways, and it is expected to show whether the risks are so great as to necessitate an early transformation of the present system of coupling. In any case, a solution of the problem appears to be inseparable from the general plan which the International Railway Union seeks to carry out for improving traffic conditions on the Continent and increasing railway speeds. That plan provides for many changes, such as the determination of curves which will permit of wider coaches being used and the fixing of rail and tire sections. The transformation thus involved is so vast that it can only be carried out gradually, and it necessarily follows that there can be no compulsory adoption of automatic couplings until something more definite is known of the plan which will be ultimately followed for general railway standardisation on the Continent.

Literature.

Economics of Rail Transport in Great Britain. By G. E. R. SHERRINGTON, M.C., M.A. (Cantab.). London: Edward Arnold and Company. Two volumes. Price 12s. 6d. per volume.

WE give a very hearty welcome to Mr. Sherrington. The number of reliable writers on railway economics could always be counted on the figures of one hand. The earliest in our own country was Nicholas Wood—who was perhaps more an engineer than a teacher of economics—and then came Dionysius Lardner, to be followed, after a gap of forty years, by W. M. Acworth, whose contemporaries were Gustav Cöhn in Germany and A. Colson in France. America has been rich in its teachers, as there have been A. M. Wellington, W. Z. Ripley, and—the greatest of all, the world over—A. T. Hadley. The best known to us of the foregoing is Acworth, who long was in possession of the field here and left us only American writers as alternative authorities. His earlier efforts, however, were, it must be admitted, those of the dominie and somewhat biassed by his admiration of American railway methods, and his poor opinion of British railways because they had not adopted ton-and passenger-mileage. In passing it may be remarked that those statistics were forced upon the railways here when the Ministry of Transport was in its heyday and the companies almost at its mercy, but one has yet to learn that the expense incurred in their preparation is in any way near justification, and we feel confident that the abolition of some of them would be a welcome relief in these days when economies are so necessary. Few people would be any the worse by their absence. Mr. Sherrington, on the other hand, has apparently approached his subject without any prejudices. We are not told that he possesses actual railway experience, but judging by the fact that the Foreword to the present work is by Sir Guy Granet, it may be assumed that he has had opportunities to study his subject at first hand. That such studies were effective is indicated by the mention in the Foreword that the author has been engaged in the study and teaching of economics and transport questions at Cambridge, Cornell and London Universities, and, judging by the results now before us, we agree with Sir Guy that Mr. Sherrington has a trained mind and that "he has brought a grasp of both general principle and practical considerations into service to an unusual degree."

The present work is most timely in its appearance. In few countries is the railway situation the same as before the war. The railways of the United States had Federal control thrust upon them just before America entered the war. It was a costly lesson, but, in the knowledge it brought of the costs of State management, the expenditure had its compensations. Under the Transportation Act, 1920, consolidation is to be effected, but it is to be voluntary, and the only condition—a pretty stiff one—is that such consolidations are to be within a scheme prepared by the Inter-state Commerce Commission. The German railways are now company-operated and the relations between the French railways and the State have been enlarged and strengthened. In our own country there have been the greatest changes. Not only have the main line and subsidiary companies been grouped into four large systems but the fixing of the charges has been taken out of the hands of the companies, which are to be allowed such charges as would, however, guarantee the same net receipts as in the year 1913. Now, a new factor has been introduced, viz., the concession to own and operate road transport services. Great then is the necessity for a study of "The Economics of Road Transport."

The present work is divided into two volumes, the first of which covers History and Development. Noting first the latter part of the subject, we would observe, not as criticism but as an indication of its purpose, that the first chapter might have been entitled "The World's Debt to Transportation." How true it is, as related by the author, that transportation has secured the unification of nations. Our own country is an example of that, and "If Ireland had possessed rail communication with Great Britain, would not the so-called Irish problem have been settled by Stephenson, Locke, Hackworth, and their contemporaries?"; and "If railways had been introduced earlier into the United States, would we have ever had a Civil War?" Again, "in South Africa, perhaps the best example of all, the co-ordination of a railway system has formed a nation not a quarter-of-a-century ago riven with unhappy racial dissensions." The way in which London was outside any of the early railway schemes, "no doubt because it was far removed from important mineral areas," is well brought out, as is the failure to realise that railway communication through London would be necessary.

Until quite recently no one has had the courage to question the younger Brunel's standing as an engineer. Possibly the first adverse criticism of that able engineer's policy was in our own series of articles "One Hundred Years of British Railways," in the second half of the year 1924. Therein it was pointed out that Brunel's original track failed; that he, next to Cubitt, was the keenest advocate of the atmospheric railway, and that the "splendid isolation" the broad gauge was to give to the Great Western was to be that company's undoing. Mr. E. T. MacDermott, in his "History of the Great Western Railway"—reviewed in THE ENGINEER of December 16th, 1927—was particularly severe on Brunel—surprisingly so seeing that he has always been that company's patron saint. Mr. Sherrington now deals with that subject in a very impartial way. He remarks:—"The turning point in Great Western Railway history was the year 1859, which witnessed Brunel's death on September 15th, at the comparatively early age of fifty-three." The withdrawal of broad gauge trains between Oxford and Birmingham, and the conversion of the Oxford, Worcester and Wolverhampton from mixed to standard gauge happened that year, and "Thus the fruits of the first gauge battle of 1845 and 1846, which had been left drawn but mainly in favour of the broad gauge, began to melt away less than fifteen years afterwards."

The change in public opinion, in the middle 'fifties, from favouring amalgamation to the encouragement of competition is very well discussed. "For the development of the country it is doubtful if placing the two main lines to the north under a single management would have been adjudged as the wisest policy . . . by 1853 regulatory policies were still unformed and undetermined." Then, when relating the benefits rail communication had on the industries of Lancashire and Yorkshire the author is very happy in his remark that "The steam power which had been responsible for the railway era was also responsible for bringing the woollen mills of Yorkshire and the cotton mills of Lancashire down from their isolated valleys, chosen for their water power, to their new positions near coal supplies." The tables showing the growth of the respective constituent companies from 1865 to 1900 and again to 1922 are most instructive. Quite a good point is further made when, in discussing the London and North-Eastern Railway, it is shown that the shareholder in the former Great Eastern Railway was unfortunate in that the terms for the exchange of shares were arranged before the full force of the present trade depression had made itself felt. In contrast with the conditions in South Wales, the Tyneside and the Clyde district "increased facilities for handling the freight traffic on this Great Eastern section of the present London and North-Eastern Railway have become essential and are being pushed ahead with expedition."

Continuing our review of the development section of Volume I., we would say that the four chapters on Permanent Way, Locomotives, Carriages and Wagons respectively are excellent. The two tables at the end of that on Locomotives—Table VII., Recent British Express Locomotive Engines, and Table VIII., Wheel Arrangement of Tender Engines—are very useful. In the chapter on Wagons, the subject of the privately-owned wagon is, however, dealt with by the author as by all writers who view the question from the railway point of view. He says that the trader preferred for many years to retain the 8-ton wagon. Reference, however, to the Railway Wagons Census of 1918 shows that out of 383,754 privately-owned wagons registered by colliery proprietors only 406 were under 8 tons and 61,483 of between 8 tons and under 10 tons; and of 146,663 owned by coal and coke distributors the corresponding figures were 365 and 34,681. In other words, 84·7 per cent. of the privately-owned wagons were of a capacity of 10 tons or over. The Railway Returns hitherto have only given particulars of "under 8 tons," and of "8 tons up to 12 tons," but from now they will give 8 tons to

10 tons and 10 tons to 12 tons. We have not yet, therefore, the comparable figures, but we doubt if the companies' returns will prove to be better, or even as good in that respect. We quite agree with the author that the bogie freight wagon is, at present, unwanted on British railways.

The two chapters on Government Regulation—1830 to 1900 and 1900 to 1925—are uncommonly good. It is refreshing to find the sixty millions paid to the companies, under the Railways Act, 1921, shown in their right light. Too often that payment has been represented as in the nature of a gift; a solatium paid as an act of grace in return for the acceptance of grouping and the other drawbacks of that Act. It was nothing of the sort but, as the author shows, a "settlement of their complicated claims against the Government for services rendered during the war and post-war period." In discussing the way in which the companies disposed of their respective portions, and in answering the criticisms made thereon, one further point might have been mentioned. It is that the sums received could not be spent on any capital works, *e.g.*, in the electrification of the London areas of the London and North-Eastern.

In discussing the grouping of the railways, Mr. Sherrington does good service to those who designed and those who have carried through the Act by pointing out that "the prosperous concern was, by the savings of large-scale production, to be able to carry the weaker with it," and that "it is the natural disinclination of the strong line to take over the weak except under very advantageous circumstances," and "it is very doubtful to what extent amalgamation would have taken place if left to voluntary schemes." We may add that immediately after the first of these three quotations it is remarked that, "Looking back, the savings to be derived in this manner in a short time appear to have been greatly over-estimated." Further good service in the same quarter is rendered by the observation that "It says much for those responsible for the financial guidance of British railways that so many of the amalgamation schemes were completed with so little friction."

The mention of the powers given to the Ministry of Transport under Part II. of the Act of 1921 to confirm agreements for the purchase, lease or working of railways, reminds us that earlier in the same Act—Sec. 16—the Minister is given power—extended by the Railways (Authorisation of Works) Act, 1923—to make Orders for the carrying out of certain works. Public notice, it is true, is given of the issue of such Orders, but no permanent record exists, and that omission may be an inconvenience to some future historian of railways who may be looking for the authority to construct certain works. As an illustration there is the Ramsgate new line of the Southern Railway which, as it cost less than £500,000, was made under an Order of the Minister of Transport. Mr. Sherrington mentions the Railway Construction Facilities Act of 1864 as permitting railways, where landowners concerned agreed, to construct a line under an Order of the Board of Trade and without the sanction of Parliament. We may remind our readers that Clause 65 of the Act in question required the Board of Trade to submit an annual report to Parliament of "the applications to and proceedings of, the Board of Trade under this Act." It seems to us that some similar return should be made of the Orders issued by the Ministry of Transport. The list might form an appendix to the Railway Returns. By the way, the present author makes no mention of the above amending Act of 1923, although his record covers up to 1925.

Part IV. of the Act of 1921, which deals with Wages and Conditions of Service, is discussed at length. It is said that it "attempts to grapple with a labour situation aggravated by the violent fluctuations in price level during the war, to which has been added a trade union system unequalled in its power and organisation by that of any other country in the world and hardly excelled by that of any other important trade or industry in this country."

The historical portion of Vol. I. is also very well done, but, because of not a few errors, it is not as good as that dealing with the development of railways. Most of the slips are small, but, however minor, they reduce the value of the book as a work of reference. We are all liable to err and to make mistakes, but the giving of incorrect years in a history is hardly pardonable. Especially is that the case in the present instance, in view of the assistance Mr. Sherrington apparently had at his disposal.

These are some of the errors we noted. The editor of the railway periodical mentioned in the preface spelt his name "Herapath." It cannot be said that there was "great opposition" to the Stockton and Darlington; the only objections, except those of some landowners, came from the advocates of a canal instead of a railway, and from those who wished the line to take a different route. The station at Victoria, mentioned on page 67, belonged to the London, Chatham and Dover and not the South-Eastern Railway. It is rather remarkable that a railway historian should spell Whaley Bridge incorrectly, seeing that it was the terminus of that remarkable railway, the Cromford and High Peak. Burton-on-Trent had railway communication in 1839; what happened in 1848 was the extension to that town of what became the Leicester and Burton branch. George Hudson had nothing to do with the Midland reaching Nottingham. That was done by the Erewash Valley coal-masters by bringing the Midland Counties Railway from Rugby to Nottingham and Derby in 1839. The Midland extension to London was sanctioned prior to 1867; it was authorised in 1863 and was opened for goods traffic on September 7th, 1867. In giving Allport's career it might have been mentioned that he was on the Birmingham and Derby Railway, and, on its incorporation with the Midland Railway, was persuaded by Hudson to go North to manage the York, Newcastle and Berwick. Those who were acquainted with the West Lancashire Railway in its independent existence would hardly say that it "helped to build up the Lancashire and Yorkshire in the county of the Red Rose."

Mention of the Lancashire and Yorkshire Railway prompts a correction of the statement as to the electrification near Manchester in 1904 and 1906. Whilst those years saw the opening of the electrical services in the Liverpool–Southport area, not for another ten years—until 1916—was there any electrification near Manchester. The Caledonian did not make the Callender and Oban line; that was done by an independent company which had its own officers. It is interesting to note that the Callender and Oban remained an independent company until the Railways Act, 1921. The Furness did not join the Midland at Wennington; the Carnforth–Wennington line was built and owned jointly by the Furness and Midland, and the latter company, further, had a share in the ownership of Carnforth Station. The electrification in the Newcastle area of the North-Eastern was not done in 1903 but in July, 1904, and it was not "ten years later" but in 1915 that the alternate-current operation of freight trains between Shildon and Newport was brought into use. The Marple and New Mills line—actually the Marple, New Mills and Hayfield Junction—did not become part of the Manchester, Sheffield and Lincolnshire in 1863 but in 1865. It was opened in 1868, and under an Act of that year became jointly owned by the M. S and L. and Midland Companies. It, further, is not correct, as stated in the same paragraph, that the locomotive power for the Cheshire Lines Committee is furnished by the parent companies, *i.e.*, the former Great Northern, Great Central and Midland Companies; the Great Central and its successor, the London and North-Eastern, have always done that. The first Tay Bridge was opened in June, not in July, 1878.

The present passenger communication was adopted before the "early twentieth century." It came in the middle 'nineties, after being introduced on the M.S. and L. in 1890, and had become standard in 1899, in which year it was officially accepted by the Board of Trade. The introduction of restaurant cars did not abolish the stops for meals "at such stations as Crewe, Rugby and York," but only at Preston, Normanton and York. The Blue-books on accident reports are no longer presented to Parliament. When that was done, hundreds of copies were wasted by Members of Parliament exercising their right to have a copy, and a fine piece of economy was effected when, early after its institution, the Ministry of Transport stopped that practice; made the quarterly reports and the annual returns into Stationery Office publications, and left only the annual report to be presented to Parliament. In alluding to accidents, we would like to enlarge on the Railway Employment (Prevention of Accidents) Act, 1900, which, it is observed, "marked an effort on the part of Parliament to lower the human cost of rail transport." The origin of that legislation is to be found in the impression prevailing in certain quarters at the Board of Trade—but not among the railway inspecting officers—that automatic couplings were desirable. An effort had been made to get them ordered by the Act of 1889, but the proprietors of privately owned wagons successfully opposed that course. Mr. Francis Hopwood—now Lord Southborough—went to Canada and the United States in 1898, and the Memorandum—White Paper C. 9183—he prepared on his return strongly recommended automatic couplings. Mr. Ritchie thereupon introduced a Bill to enforce them, but again the private owners of wagons intervened, and the result was the Royal Commission of 1899 and the above-mentioned Act of 1900. As the railway companies had two representatives on the Commission, and as the recommendations contained in the report were unanimous, it does seem as though some credit should be given to the companies for assisting in the "effort . . . to lower the human cost of rail transport." It may incidentally be remarked that automatic couplings for wagons have not yet been adopted, and that there is no need for such action is indicated by the fact that only four servants were killed whilst coupling or uncoupling vehicles—including passenger stock—in 1927.

Mr. Sherrington has got confused in his facts as to "the beginning of the series of industrial disputes." It was the dispute of 1907 that led to the conciliation scheme of that year, and it was the unsatisfactory working of the latter that led to the strike of 1911—there was no strike in 1907. In the succeeding paragraph reference is made to the recommendations of the Railway Conference. That is the only mention in the book of that body, and something more is necessary. It was the outcome of Mr. Lloyd George's discovery, when at the Board of Trade and having to meet the companies over the 1907 conciliation scheme, that they were less black than painted, and so, in February, 1908, he appointed the Railway Conference, which was further noteworthy by having no terms of reference and unlimited powers for the co-option of members. Then, when leading up to the Railways Act of 1921, the author says that Government control was extended until March, 1920, we think he has confused Federal control of the American railways with the control here. The former ceased at 12.01 a.m. on March 1st, 1920. Government control of British railways ceased on August 15th, 1921.

Mr. Sherrington has been guilty of the common error as to the powers for State purchase granted by the Act of 1844. We have yet to find a writer who presents the true facts, and it comes as a surprise that the present work should not have done so. It is not correct that "under the same Act—that of 1844—the Government was given power to purchase at the end of twenty-five years." Reference to the Act itself will show that whilst Sec. 2 says, to quote the marginal note, "The Treasury may purchase future railways," and names the terms of such purchase, Sec. 4 lays down that "Whereas it is expedient that the policy of revision (of tolls, fares, and charges) or purchase should in no manner be prejudiced by the provisions of this Act, but should remain for the future consideration of the legislature, upon grounds of general and national policy," no action is to be taken until Parliament had passed further legislation authorising the guarantee or the levy of the purchase money. Thus, further legislative action is still necessary before State purchase can be effected.

Another common error, and one very annoying to an engineer, is made by the author. He says it is "the loading gauge, that is, the width and height of vehicles, which determines the existing size of our carriages and freight wagons." It is nothing of the kind; it is the structure gauge, *i.e.*, the height, width and clearances generally of tunnels, bridges, platform walls, side girders of underbridges, &c. The structure gauge determines the outside dimensions of locomotives, carriages, and wagons; the loading gauge really is what its name implies—it regulates the dimensions as to height in the centre and at the sides and the width that a load, *e.g.*, of a wagon, shall occupy, in order to clear the tunnels, bridges, &c.

We now reach Vol. II., which deals with Rates and Service. That part we find to be on the same high level as the Development section of Vol. I. We have made several marginal notes where we have been impressed by what Mr. Sherrington has said. For instance: "One reads constant protests that transport charges often amount to 50 per cent. of the total selling price of the article. It should hardly be a matter for surprise. That the products of Alberta are enabled to compete with those of Southern Russia, Australia and Argentine is surely a silent witness to the efficiency of the world organisation of transportation." The chapter on Internal Organisation is uncommonly instructive as showing how a property with a capital of over £1,000,000,000 and handling nearly £50,000,000 a year is cared for. Incidentally, the charts of various organisations indicate why, apparently, it takes some time to arrive at decisions.

Another good chapter is that on British Railway Finance. A fact therein which surprised us was that brought out in Table IV., namely, that the average rate of interest or dividend paid per cent. of receipts from capital in 1913 was not materially different from that of 1925. That shows that there is little ground for the complaints as to the low returns on capital being paid by British railways. Yet more instructive—in fact, it has been a pleasure to read—is the chapter on the Railways and the Trader, and particularly in the concluding sentences: "The saying is common in America and it is not uncommon here that a large trader suffers more through bad service than through a slightly higher level of rates. Given the choice, he will prefer the latter. . . . Good feeling and co-operation between buyer and seller are essential in every industry, but in none are they more important to the social well-being than between the railways and their users." With the remark that the whole of these two volumes are filled with such sound sense as that just expressed, we think we need say no more to commend them to our readers.

BOOKS RECEIVED.

The Price of Petrol. By E. H. Davenport. London: The London General Press, 8, Bouverie-street, E.C. 4. Price 1s. net.

The Yorkshire, Nottinghamshire and Derbyshire Coalfields, South Yorkshire Area: The Parkgate Seam. London: His Majesty's Stationery Office, Adastral House, W.C. 2. Price 3s. net.

Specification for Architects, Surveyors, Civil Engineers and for all Interested in Building. Edited by F. Chatterton, F.R.I.B.A. London: The Architectural Press, 9, Queen Anne's Gate, S.W. 1. Price 10s. 6d. net.

Engineering for Forest Rangers in Tropical Countries, with Special Reference to Burma. By A. H. Lloyd. London: Humphrey Milford, The Oxford University Press, Warwick-square, E.C. 4. Price 17s. 6d. net.

The Deterioration of Colliery Winding Ropes in Service, with Descriptions of Some Typical Failures. By S. M. Dixon, M. A. Hogan and J. M. Robertson. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 1s. net.

The P. and O. Turbo-Electric Liner "Viceroy of India."

No. II.*

In our last issue we described the new P. and O. turbo-electric liner "Viceroy of India," and gave a general account of the hull design, the deck auxiliary machinery, and the passenger accommodation. We outlined the main features of the twin-screw turbo-electric propelling machinery, the lay-out of which was illustrated by a special four-page Supplement, in which machinery arrangement drawings and views of the boiler and engine-rooms were reproduced. Finally, the boiler installation was described, and particulars were given of the special arrangement of the steam pipes and the pressure and water gauges.

In to-day's issue on page 268 we reproduce four other views, taken in different parts of the engine-room, which, when studied in conjunction with the illustrations given in last week's Supplement, will enable the reader to obtain a clear idea of the way in which the main and auxiliary propelling machinery is laid out, and its general appearance.

The lower right-hand engraving, Fig. 9 shows the control platform, as it is seen when looking forward from the main entrance to the engine-room on D deck. In the centre of this view is the control cubicle for the alternators and motors, in front of which the engine-room telegraphs are placed. The very roomy and comfortable starting platform thus given may be noted. To either side are the two main turbo-alternators. These are three-phase machines, each having a maximum rating of 9000 kW output when running at 2690 r.p.m., and with a pressure of 2720 volts. The maximum speed rating is 6536 kW, 3110 r.p.m., 3150 volts, three-phase. The two main propelling motors are sychronous machines, each having a designed output of 8500 S.H.P., when supplied with 3150 volt three-phase current, and running at 109 r.p.m. A view of the port motor is shown in the lower left-hand view Fig. 8 on the same page. We shall refer later to its design.

Turbo-alternator Speed Controls.

In Fig. 12 we reproduce a longitudinal section through one of the main turbines. The machine is of the standard B.T.H. pattern, with eighteen stages, the working steam pressure being 350 lb. with a total temperature of 700 deg. Fah. Suitable tappings are provided for the three-point bleeding in connection with the closed feed system shown in Fig. 14. One of the most interesting parts of the turbine is the patented governor control gear and the means used to regulate the speed of the turbine from the control panel. A general view of the control platform is given on page 268, and Figs. 10 and 11 show the main stop valves, steam controls, and the governor gear at the forward end of the turbine. Below the centre control panel are three levers for each propeller, which operate the necessary electrical and mechanical controls for reversing the motors and for regulating the speed of the turbo-alternator sets. One lever controls the solenoid and cam-operated contactors for the reversing operation, and the other two levers are connected to the turbine speed control gear and the field controls.

The direction lever having been placed in the ahead or astern position, the two speed control levers, which are interlocked one with the other, are then operated. The function of the first lever is to actuate the mechanism which controls the speed of the turbine from the maximum of 3110 r.p.m. down to approximately 700 r.p.m. To obtain any further reduction of speed the second lever has to be moved. When it has reached the half-travel position the first lever ceases to operate the turbine governor mechanism, and begins to control the field of the turbo-alternator, and the interlocking gear is such that the second lever cannot be moved from its position until the first lever has moved through half its travel, this applying equally both when reducing and when increasing the speed. The turbine speed between 3100 r.p.m. and 700 r.p.m. is varied by means of a centrifugal governor under the control of the first lever. For any given setting of the lever the turbine speed remains constant within the limits of the governor range. The actual steam admission valves, which are shown to the left of Fig. 12, and also in Figs. 10 and 11, are operated by means of a servo-motor, which derives its power from the forced lubrication system. A pilot valve regulates the flow of oil to and from the servo-motor, and this valve is also under the control of the centrifugal governor.

In order to prevent more than maximum power being applied to the propelling motor, when each motor is coupled to one turbo-alternator, an automatic arrangement, which permanently closes a certain proportion of the steam admission valves when the turbine is running at any speed above 2690 r.p.m., is fitted. As the working of this gear is entirely automatic, it is claimed that the accidental or premeditated overloading of the propelling motors is effectually prevented. The control of the turbine speed below 700 r.p.m. is effected by the movement of the second lever working in conjunction with an hydraulically-operated float-governor. The governor is connected through a system of levers to the pilot valve, already referred to, which governs the flow of operating oil to and from the servo-motor in accordance with the governor demands. In the slow-running position of the second lever, the steam admission valves are practically closed, so that the propelling motors turn at very slow speeds. Such operation is very advantageous, both when manœuvring and when passing through the Suez Canal.

The comparative simplicity of the actual controls can be judged by the following sequence of starting operations :—When the slow speed levers have been placed in the "open" position and the direction levers are in either the ahead or astern position, as may be required, the field control lever is moved into the first notch and the side latch then lifted. When the speedometer shows the two pointers opposite each other, the lever is moved to the third notch, and the propelling motor then pulls into synchronism. As soon as the motor has synchronised the side catch is again lifted and the lever moved into the fourth notch or the running position. After that is done the speed of the sets is adjusted. A micrometer adjustment is provided on the speed lever, so that very fine speed settings are easily obtained. In actual service the controls are found to be very simple, and the ship quickly responds to the movement of the propeller.

Propelling Motors and Alternators.

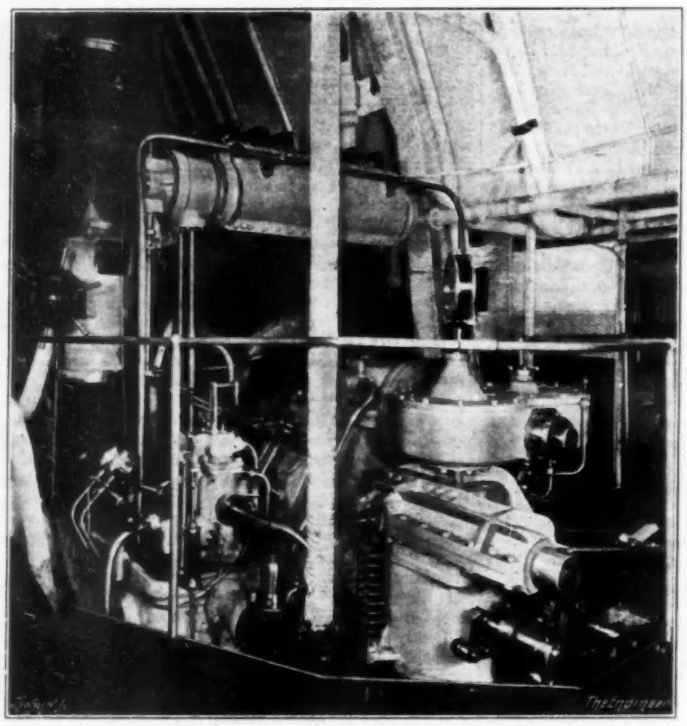
The propelling motors, one of which is shown in Fig. 8, page 268, are of the salient pole synchronous type and are coupled direct to the propeller shafts at the after end of the engine-room. The electric drive permits the arrangement of the propelling motors at the stern end of the ship, enabling the tunnel shafts to be dispensed with, but in the case of a large liner like the "Viceroy of India," it was more convenient to have all the machinery in one engine-room, thereby centralising the control. Moreover, the space between the tunnel shafts is advantageously used for the refrigerating machinery installation and for the storage of large spares.

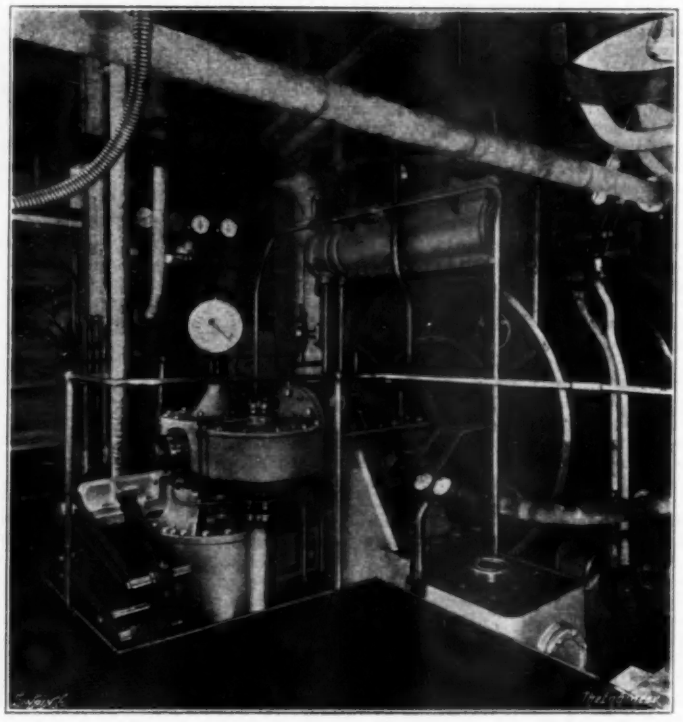
The motors are of the end shield bearing pattern, a design which provides a robust and self-contained unit. The synchronous motor can also be made with a comparatively large air gap without undue loss of efficiency. The stator frame is of cast iron and all other principal parts, such as rotor spiders, bearings, &c., are of cast steel. The bearings are white metal lined, and they are mounted in spherical seatings. Ring lubrication is fitted, and an auxiliary oil pump is also provided, special precautions being taken to prevent the oil from gaining access to the inside of the motor by creeping along the shaft.

Under full power conditions each motor is electrically connected to one turbo-alternator, and is independent of the other set. At reduced powers, however, only one turbo-alternator is used, and it supplies current to both motors. Either turbo-alternator set can be so used, the other set standing in reserve. In designing the equipment special consideration was given to the propeller characteristics, and the characteristics of each machine, so that there should be harmony throughout the system. It is interesting to note that the speed reduction ratio between the prime mover and the propeller, given by the combination of the turbo-alternator and the synchronous motor, is of the order of 28 to 1.

Both the alternators and the propelling motors are equipped with a completely enclosed ventilating system, the air for the cooling of the machines being forced through the core and the windings and returned through an air cooler by an independent motor-driven fan. There are two sets of fans and motors for each propelling motor air circuit, each set being designed for the full duty, so that one can be used while the other remains in reserve. By means of dampers fitted in the air-trunking system either of the two ventilating fans can be quickly brought into use. Thermo-couples are embedded in the stator windings of the motors and alternators, so that the temperatures can be read directly at the control panel. Direct reading thermometers are also fitted in both the inlet and outlet sides of the motor air-cooling circuits.

At the after end of the engine-room on the port side there is a well-arranged engineers' workshop, which is equipped with a lathe, a drilling machine and a grinder, all of which are electrically driven. Electricians' shops are provided near the engineers'





FIGS. 10 AND 11—END VIEWS OF MAIN TURBINE SHOWING STEAM CONTROLS AND GOVERNOR GEAR

* No. I. appeared March 1st.

quarters on the boat deck, which are served by an electric lift from the control platform.

AUXILIARY TURBO-GENERATOR SETS.

For the purpose of supplying electric current for power, lighting purposes, ventilation and cooking, there are four auxiliary turbo-generator sets arranged in pairs in the wing spaces at control platform level. The upper view, Fig. 6, on page 268 shows two of these sets looking aft on the starboard side of the engine-room. Each set has a designed output of 500 kW, and the turbine, which runs at 8000 r.p.m., is geared down to 670 revolutions, which is the designed speed of the 220-volt generator. To the left of our illustration there will be seen the main stop valve and the governor controls. The sets are very compact and they are easily accessible for supervision and overhaul.

CONDENSERS AND CLOSED FEED SYSTEM.

The top right-hand view, Fig. 7, on the same page, taken at tank top level looking forward, shows the two main condensers with the two turbine-driven boiler feed pumps, and the two vertical motor-driven extraction pumps with the air ejectors, in the background. The feed system fitted on the "Viceroy of India" is of the closed-feed patented internal-capacity type, and the equipment was designed and supplied by G. and J. Weir, Ltd., of Cathcart, Glasgow. As will be seen from Fig. 13, which is a diagrammatic section through the condenser, the shell is of the inverted boat-shaped type, the inlet flange being offset from the centre in order to accommodate the special shape of the exhaust flange on the turbine shown in Fig. 12. The bottom of the condenser is made in the form of a large reservoir, which functions as, and takes the place of, the ordinary feed tank. There are also distilled water and fresh water tanks arranged in the double bottom spaces but they simply serve the purpose of make-up tanks in the ordinary way.

The main condenser is of the Weir regenerative type. There are two nests of tubes, an upper one which is cooled by the second pass of water, and lower nests through which the cooling water is first passed. The arrangement of the tubes is such that the entering steam penetrates to the bottom of the condenser, and in doing so reheats the condensate which rains down from the tube nests in the upper part of the condenser shell. The final steam flow is arranged to take place in an ascending direction, and a certain amount of tube space is provided which acts as a self-adjusting air cooling medium. The air is taken off by the air ejectors, and the condensate is delivered at vacuum temperature and free from air.

During the trials the temperature of the condensate averaged from 1 deg. to 2 deg. Fah. above that of the entering exhaust steam. A vacuum of 28·9in. was maintained, and the fuel consumption for all purposes corresponding to that vacuum was 0·715 lb. of oil per S.H.P. hour, which, when corrected for a vacuum of 28in., corresponds to the figure of 0·74 lb. referred to in our last article.

A float-operated valve is attached to the reservoir chamber of each condenser to maintain a constant water level. The motor-driven vertical extraction pumps withdraw the condensate from the reservoir in the condenser base and deliver it through the third stage coolers of the air ejectors, the drain cooler and the low-pressure heater to the feed pump suction. The feed pump delivers through both the intermediate and high-pressure heaters to Mumford feed-water regulators or the steam drums of the Yarrow boilers. Both the intermediate and high-pressure heaters are of the multi-flow pattern. The air ejectors are of the Weir three-stage type with inter-cooling.

The drawing reproduced in Fig. 14 shows the general scheme of the feed system, with three-point bleeding from the main turbines, and serves to indicate the pressures at the different points.

A low-pressure evaporator, which has a make-up capacity equivalent to 3 per cent. of the total feed water, is fitted, and this evaporator is designed to take steam from the thirteenth stage of the turbine, the vapour being led back to the fifteenth stage range. There are also two 40-ton high-pressure evaporators, one of which is designed to use bled steam, and a distilling condenser of the same capacity. For the production of fresh water for drinking purposes there are two sets of evaporators and distillers, each having an output of 20 tons of water per twenty-four hours. During the recent sea trials all the designed feed temperatures were attained.

Brief reference may be made to the more important pump equipment. The main feed pumps are of the Weir turbine-driven single-stage centrifugal type. There are two units each with a designed output of

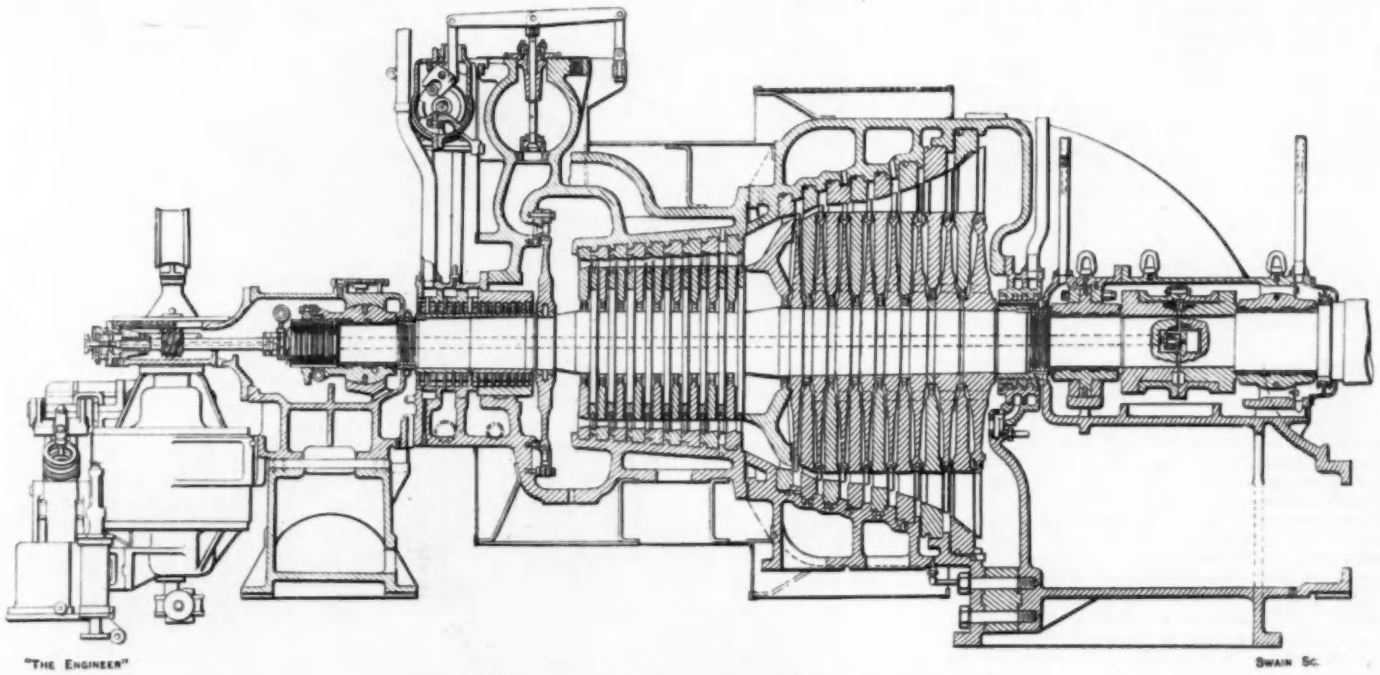


FIG. 12—LONGITUDINAL SECTION THROUGH MAIN TURBINE

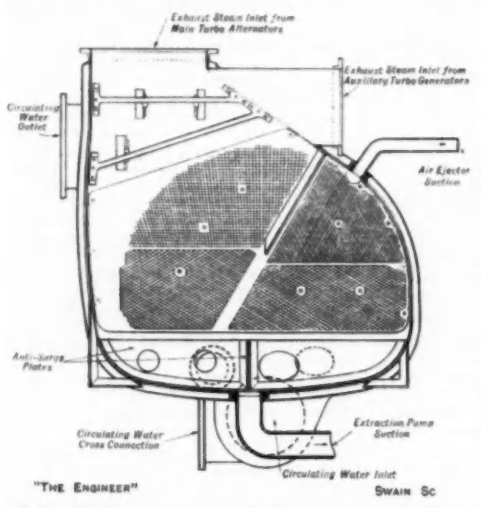


FIG. 13—SECTION THROUGH MAIN CONDENSER

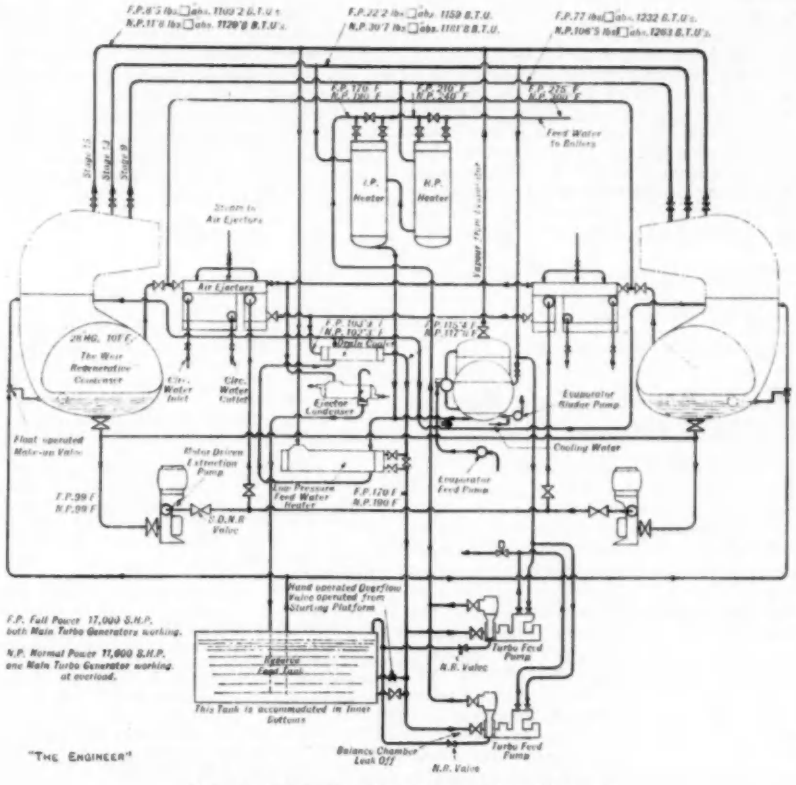


FIG. 14—DIAGRAM OF CLOSED FEED SYSTEM

20,000 gallons of feed-water per hour, delivered against a discharge pressure of 460 lb. per square inch when supplied with 375 lb. steam at a total temperature of 750 deg. Fah., and exhausting either to 28in. vacuum or working against a back pressure of 20 lb. per square inch absolute.

The pumps are of the latest pattern, and Monel metal blading is fitted to the turbine, while the impeller is made of the same metal. The pump bodies are made in high-tensile bronze alloy, and to meet the vacuum conditions special sealing gear has been fitted. The pump itself is balanced by means of an internal pressure equalising system, and end thrust is done away with, the balancing device being designed to operate under all load conditions. There is a pressure governor on the discharge main, which maintains a constant delivery head, irrespective of fluctuations in the steam pressure or in the quantity of water pumped. The sets are so designed that they are self-regulating under all ordinary changes either in the steam or water conditions.

The auxiliary boiler feed pumps are of the Weir direct-acting steam-driven type and the auxiliary air pumps are of the electrically operated twin type. Other electrically-driven Weir pumps are a 250-ton ballast and 190-ton per hour bilge pumps, which are of the two-throw motor-driven type, the motor operating on the "Austin" constant-current variable-voltage system; similar types of two-throw pumps are used for the oil fuel system. The main circulating pumps were supplied by W. H. Allen, Sons and Co., Ltd., of Bedford.

There are two sets, one for the port and the other for the starboard main condenser. They are of the horizontal single-stage double-suction type with 33in. diameter inlet branches. The casings are split on the centre line of the pump and the branches are so disposed that the impeller can be inspected without having to break the pipe joints. Each pump is designed to deliver 22,000 gallons of water per minute against a head of 27ft. The pump bed-plate is directly bolted to the motor bed-plate, which carries a two-pedestal bearing marine type motor having a designed output of 250 brake horse-power. The speed of the motor can be varied between a maximum of 440 revolutions per minute and a minimum of 250 revolutions per minute. Automatic starters with push-button controls and with a special speed regulator, mounted on the main control panel, are provided. Other pumps supplied by W. H. Allen, Sons and Co., Ltd., include the 7in. and 9in. pumps for auxiliary circulating, bath, and sanitary duties. These pumps are all of the vertical-spindle single-suction single-stage type driven directly by vertical-spindle motors.

The lower left-hand view, Fig. 7, on page 268, shows in the background one of the two oil engine driven generating sets for port use. They comprise a four-cylinder airless injection, two-stroke, oil engine, by Petters (Ipswich), Ltd., coupled directly to a B.T.H. 165-kW, 220-volt, D.C. generator. The engine is a four-cylinder unit, with a designed output of 250 B.H.P. at 275 r.p.m., having cylinders with a bore of 14in. and a stroke of 16in. The sets are designed to run in parallel with any of the four turbo-generator sets. The emergency lighting set on the boat deck consists of a twin-cylinder 75 B.H.P. oil engine of the same type, coupled to a 50-kW generator, the unit being complete with its own switchboard and fresh water cooler. The bore of the cylinders is 11in. with a stroke of 12in., and the designed speed is 370 r.p.m.

In our third article we hope to deal briefly with the trial results.

(To be continued.)

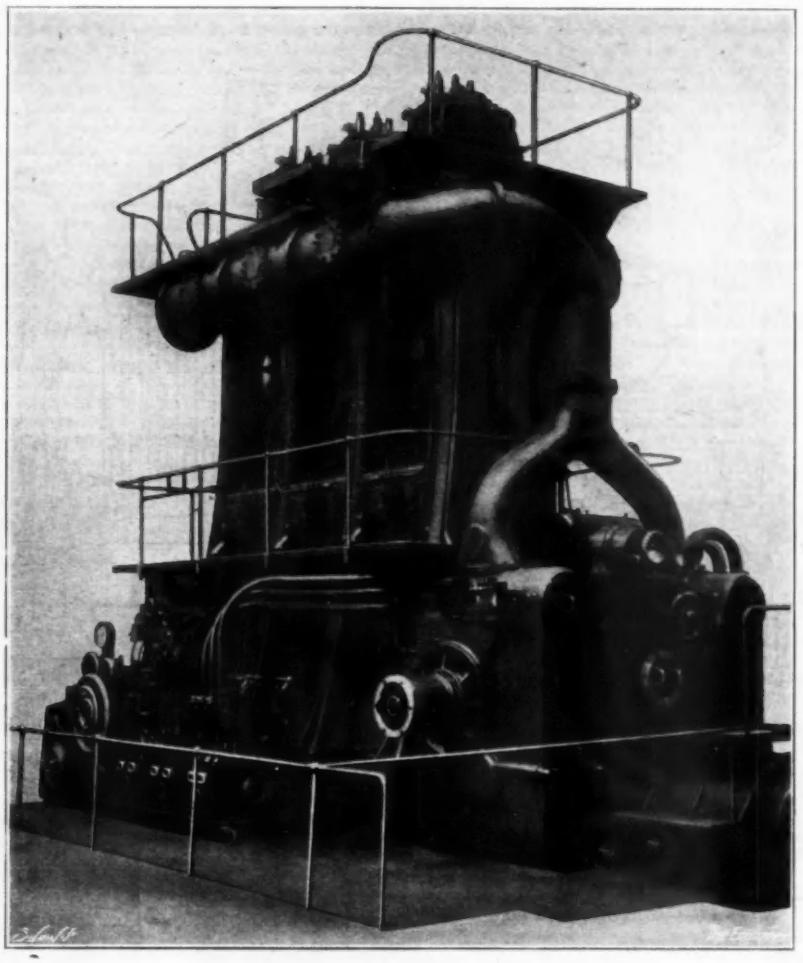
A 1250 S.H.P. Double-acting Marine Oil Engine.

In a paper entitled "High-powered Oil Engines," read before the North-East Coast Institution of Engineers and Shipbuilders in the spring of 1926, which was reprinted in an abridged form in the issues of The Engineer for April 30th and May 21st, 1926, Mr. W. S. Burn, of Richardsons, Westgarth and Co., Ltd., West Hartlepool, described a new type of double-acting, two-stroke oil engine, which had then been built and tested in experimental form. The engine, it will be recalled, was all-British in design, and it worked on the airless injection principle, with controlled fuel pump delivery and automatic fuel valves. The design was characterised by its simplicity and the readiness with which the engine could be manufactured in standardised form, in order to compete more easily in price with the steam reciprocating engine. The single-cylinder experimental unit had a bore of 26½in., with a stroke of 47½in., and it was designed to develop an output of 800 S.H.P. at 90 r.p.m. In the final series of experiments fuel consumptions of the order of 0·40 lb. per S.H.P. hour were obtained.

The first engine of this new type to be built for sea service is the three-cylinder unit for the Iranian Tanker Company, Ltd., of London, which was recently completed by Richardsons, Westgarth and Co., Ltd., for the 3200-ton deadweight tanker "Irania," built by the Blythswood Shipbuilding Company, Ltd., of Scotstoun, West Glasgow, and now being fitted out in the Rothesay Dock. The designed output is 1250 S.H.P. at 90 r.p.m., with a bore of 21½in. and a stroke of 38in. Brief reference to this new engine was made in our review of motor shipbuilding for 1928, which was published in The Engineer of January 4th. Some days ago we inspected the engine running under full load trial conditions at West Hartlepool, and in what follows a short account of the essential features of its design, together with some performance figures, is given. The experimental work done on the engine and its sea trials are to form, we understand, the subject of a new paper which is to be read by Mr. W. S. Burn at one of the later meetings of the North-East Coast Institution of Engineers and Shipbuilders at Newcastle this session.

1250 S.H.P. DOUBLE-ACTING MARINE OIL ENGINE

RICHARDSONS, WESTGARTH AND CO., LTD., WEST HARTLEPOOL, ENGINEERS



A general view of the engine is given above. It is a very compact unit, with all the manœuvring controls along with the fuel pumps arranged at the front of the engine with a novel form of direct-driven scavenge pump.

Apart from this latter feature, there has been little change from the earlier design, and the main differences we were able to note were all in the direction of the improvement of small details.

The new bed-plate is broader, being about 11ft. wide, and the general scantlings have been somewhat increased, which results in a very robust and steady engine. Considering the total height, which is 25ft. from the underside of the bed-plate to the top of the starting valve, it was of interest to find that neither side movement nor any lifting of the cylinder covers could be detected at either the intermediate or the upper platform, when the engine was running under full load.

Bed-plate, Crank Shaft and Columns.—A flat-bottomed bed-plate of the box girder type has been adopted with a self-contained oil sump. It will be seen from Fig. 1 that the longitudinal members of the bed-plate are only a little over half the depth of the transverse members, a design which affords easy access to the external holding-down bolts. The four main columns are of the "A" type box form, and they are made in two halves vertically for ease in casting. The columns carry facings at the front of the engine for the crosshead guide bars, while below these and also on the opposite side of the crank chamber are light removable inspection doors. Within each column there pass from the top of the cylinder entablature through the main bearing to the underside of the transverse bed-plate girders two long tie bolts which are in tension and take the working forces.

A built-up crank shaft is employed, and the cast steel webs have large balance weights, so that each cylinder is practically balanced as a unit, and such balance, along with that of the engine-driven scavenge pump, obviates the use of a fly-wheel.

Pistons, Piston-rods and Liners.—The piston design can be studied from the section shown in Fig. 1. The upper and lower portions of the pistons are similar and the piston tops are practically flat. Each part carries five piston rings, which are free to move in their grooves. Special provision is made for cooling the piston, particularly in the region of the top cap nut, which secures it to the piston-rod. With a water-cooled nut, no difficulty has been experienced in removing the nut, even after long periods of running. The piston-rods are hollow and carry an internal tube for the cooling water. They are made from 50-ton tensile steel, of 3 per cent. nickel quality. Cooling water is supplied from the crosshead through telescopic pipes with spring glands arranged outside and above the crank case. The whole of the cooling water fitting is so supported that it can take up its own alignment position.

The liner is made in three parts, the centre portion carrying the exhaust and scavenge air ports, which are clearly shown in Fig. 1. The exhaust ports extend about half-way round the circumference of the liner and on the opposite side are the scavenge air ports. The latter are of turbine nozzle shape—see Fig. 3—and are so shaped that they direct the entering air up one wall of the liner, across the cover, and down the other side to the exhaust openings, the angle of air entry becoming less steep as the piston descends. The shaping of the ports and the casting of the central liner with adequate water-cooling spaces within the port bars has been the subject of special research and experiment. The clear nature of the exhaust, coupled with the low scavenge air pressure of about 1·35 lb. per square inch and the successful running on widely varying grades of fuel oil are all indications of the success which has attended the designs finally adopted. The upper and lower parts of the liner are plain symmetrical castings which are enclosed by the cylinder jackets. The upper cylinder jacket forms a separate casting, while the lower one is made in one piece with the liner casting. Sliding joints enable the liners to expand both upward and downward.

Cylinder Covers and Valves.—The drawing reproduced in Fig. 2 illustrates the special type of cylinder cover employed, which is the same for both the upper and lower ends of the cylinder. Each cover is secured in position by studs, which are screwed into the water jacket flanges. The covers project into the liner, and a patented type of spring gland is used to form the gas joint. Where the edge of the cover comes in contact with the liner surface, is fitted a shrunk-on ring of special heat-resisting steel, the object of which is to protect the liner surface and to assist generally in promoting good combustion conditions. The cooling water system is such that the fuel valve bodies are entirely surrounded by water, an arrangement which makes for a cool injection nozzle. In the cylinder jackets spiral ribs are used to increase the velocity of the cooling water at points near the combustion space. Distilled water is used for both the cylinder jackets and the pistons. There are single large openings in the centres of the covers, that in the upper cover serving to house the starting valve while that in the lower cover houses the piston-rod, the stuffing-box being external.

Fuel Valves and Nozzles.—There are two fuel valves and also a relief valve on each cylinder cover. The particular arrangement of nozzle sprays indicated in Fig. 3 has been finally adopted after careful experimental work. Each of the nozzles has five apertures. Four of

them are designed to direct the spray horizontally in the manner indicated, and these jets have good penetrating qualities. The fifth jet sprays the oil in a vertical direction, and, in this case, the oil is atomised very finely by specially shaped passages within the nozzle. The oil from this single spray ignites immediately and serves the purpose of a pilot igniter for the deeper penetrating sprays.

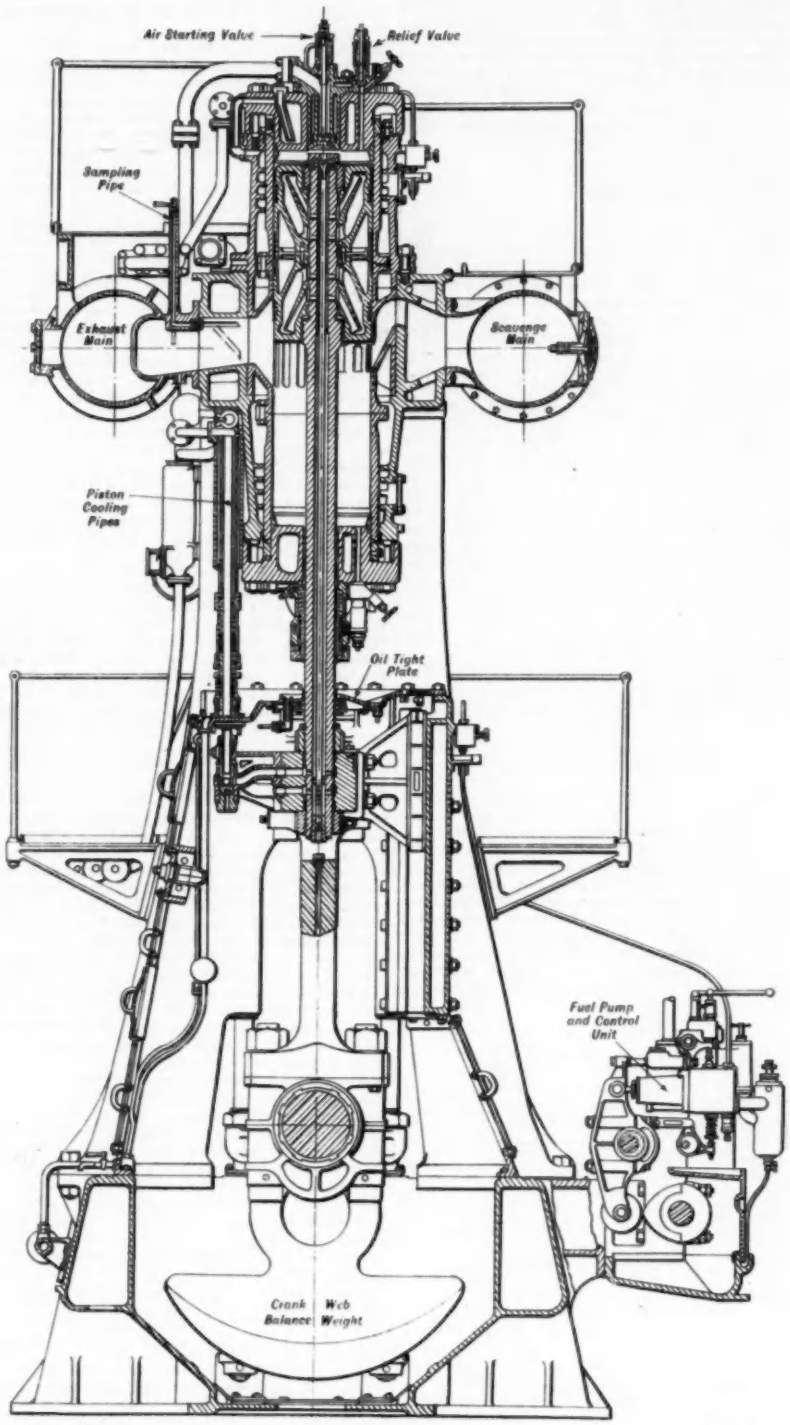


FIG. 1 SECTION THROUGH CYLINDER AND BED-PLATE

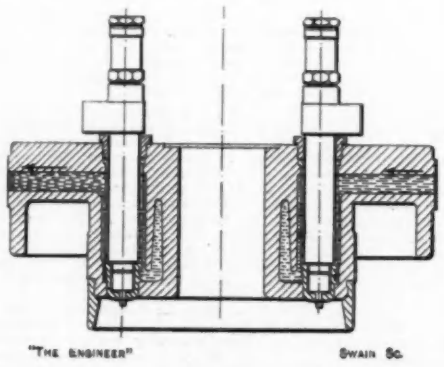


FIG. 2—CYLINDER COVER WITH FUEL VALVES

The fuel is delivered to the valves under a pressure of 4200 lb. by the pump, and as far as possible all the fuel pipes are made of the same length. Specially designed oil filters and test cocks are included in each pipe line.

Scavenge Pump and Drive.—Fig. 4 is a section through the air scavenge pump, which is driven from the crank shaft at three times engine speed by helical gearing. The driven shaft is furnished with two cranks placed at 180 deg., to which the double-acting pistons are attached by means of short connecting-rods. As shown in the drawing, each piston is supported on a cylindrical trunk guide, in the centre of which the gudgeon pin is placed. The pistons and guides are made in a light aluminium alloy, and we found the reciprocating parts to be very silent and easy in their running. Above and below the piston are the inlet and delivery valves, which take the form of light rotary valves running in ball bearings. They are driven by a duplex chain from the pump-operating shaft. The ports are so designed that each valve serves both sides of the piston and a definite timed effect is obtained in the scavenge main. Typical indicator cards are reproduced in Fig. 5, which illustrate this effect. On the top of the scavenge pump there is placed the electrically operated turning motor. Suitable inspection doors are provided, and the piston guides and crank chamber can

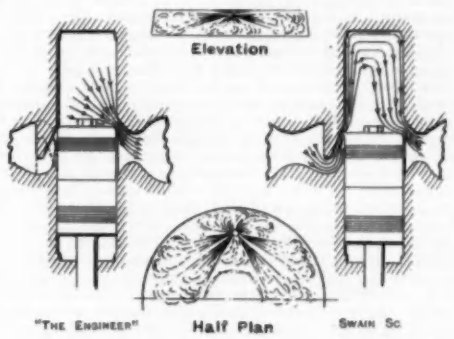


FIG. 3 SCAVENGE AIR AND FUEL DISTRIBUTION

be inspected while the pump is running. This type of pump can also be built for electric driving, should such a drive be found preferable. The only other auxiliaries which are not engine driven are the water-circulating pumps and the lubricating oil pump, which are separate units. The engine is fitted throughout with forced lubrication, and special mechanically operated lubricators are used to supply oil to the cylinder liners, the piston-rod glands and the crossheads, and also the scavenge pump.

Starting and Control Unit.—The control unit at the front side of the engine comprises the control wheels

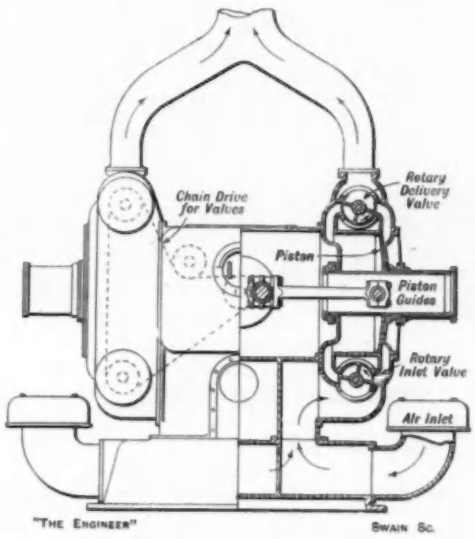


FIG. 4 SCAVENGE PUMP AND DRIVE

for air starting and fuel regulation, the ahead and astern running gear and the fuel pump, with starting and timing valves. The cam shaft is driven by two coupling-rods, which are attached to two cranks set at 90 deg., which are mounted at the forward end of the main crank shaft. A centrifugal governor also forms a part of the control unit. The fuel pumps, which are shown to the right of Fig. 3, were fully described in our account of the experimental engine referred to at the beginning of this article. The amount of fuel delivered to the spray valves is controlled both on the suction valves and by means of spill valves, and there is one pump for each cylinder end.

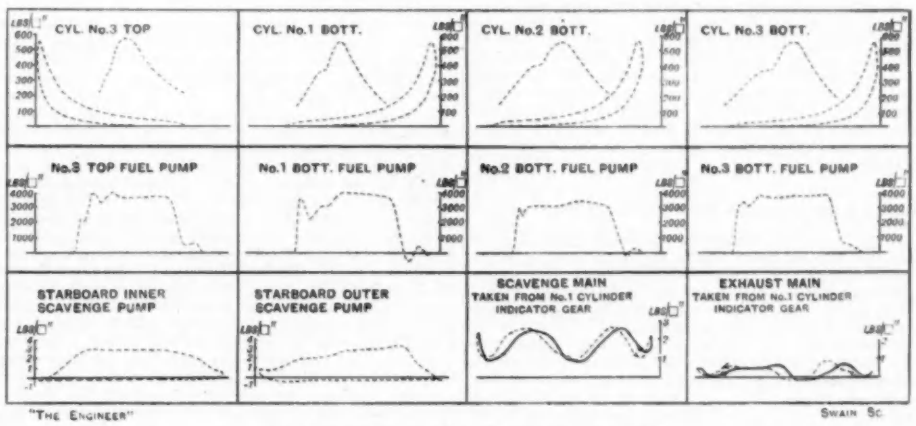

CYL. No.3 TOP
CYL. No.1 BOTT.
CYL. No.2 BOTT.
CYL. No.3 BOTT.
No.3 TOP FUEL PUMP
No.1 BOTT. FUEL PUMP
No.2 BOTT. FUEL PUMP
No.3 BOTT. FUEL PUMP
STARBOARD INNER SCAVENGE PUMP
STARBOARD OUTER SCAVENGE PUMP
SCAVENGE MAIN TAKEN FROM No.1 CYLINDER INDICATOR GEAR
EXHAUST MAIN TAKEN FROM No.1 CYLINDER INDICATOR GEAR
"THE ENGINEER"
SWAIN Sc.

FIG. 5—SOME TYPICAL INDICATOR CARDS

The larger of the two small hand wheels directly above the main manœuvring hand wheel controls the time of the closing of the suction valves, while the smaller hand

wheel alongside it turns the opening of the spill valves. By these two settings any desired time of opening and closing of the automatic fuel valves can be fixed. Some indicator cards taken from the fuel pump are reproduced in Fig. 5. They show the flat topped diagram which is obtained with a pump pressure of round about 4000 lb. per square inch.

The middle hand wheel below the fuel control wheels operates the air-starting mechanism. Starting valves of the automatic type are fitted on the top cylinder cover and are shown in section in Fig. 1, while an auxiliary air connection is led to the bottom cylinder cover, which assists in moving the engine over the dead centre. The starting air timing levers and the air pipes to the cylinders will be seen to the right of the control unit. There is a central locking wheel, while the middle one is used for consecutively admitting starting air to the top ends of the cylinder, putting the bottom ends on fuel, and finally cutting off the starting air from the top ends and putting them also on fuel. These operations are accomplished by turning the wheel smartly in one direction. The outer and larger wheel is used to put the engine quickly on to fuel. For reversing the cam shaft is moved in a fore and aft direction by throwing over a lever immediately below the starting hand wheels. Separate ahead and astern cams are provided for both the fuel pumps and starting air valves. The instruments at the control station include a tachometer, an ahead and astern indicator and pointers showing the fuel settings on the suction valves and the spill valves, besides which there are the usual pressure gauges. Open-ended discharges from the piston and water jacket cooling systems are provided within easy access of the engine attendant.

Bench Trial Results.—The indicator diagrams, which are reproduced in Fig. 5, are taken from an official full-load trial, which was run for four hours on Wednesday, February 13th. The load was applied by a water brake, and when running at 89·5 r.p.m., 1133 B.H.P. were developed, corresponding to 1301 I.H.P., the mechanical efficiency being 87·2 per cent. The fuel used was Rumanian fuel oil, of 0·881 sp. gr. The average mean indicated pressure for the three top cylinders was 75·9, and that for the three bottom cyinders was 69·7 lb. per square inch, while the average maximum cylinder pressures were 556 lb. and 541 lb. per square inch respectively. The average maximum fuel pressure for the three top cylinders was 4033 lb., and that for the bottom 3613 lb. per square inch. The exhaust was invisible, and its average temperature was only 430 deg. Fah., which showed a very cool running engine. The cooling water inlet temperature was 79 deg. Fah., and 112 deg. Fah. at the piston and cylinder jacket outlets. The scavenge air pump took 67·57 I.H.P., and the quantity of air delivered per minute was 6800 cubic feet at a pressure of 1·35 lb. per square inch. The cooling water inlet pressure loss 20 lb. and that of the lubricating oil system 15 lb. per square inch. Under these conditions the fuel consumption worked out at 0·378 lb. per B.H.P. per hour, and 0·329 lb. per I.H.P. per hour, which is a very good figure, and one which is quite representative of present-day airless injection practice. Both the designer and the builders of the engine are to be congratulated on the production of a new and promising type of marine oil engine, the sea trials of which will be followed with the greatest of interest.

American Engineering News.

The Boulder Dam.

After long controversy over the merits of a dam 550ft. high to provide for flood control of the Colorado River, and to furnish water for irrigation and power purposes, President Coolidge has signed the Bill authorising this project. At the proposed site in Black Canyon, just below the Boulder Canyon, the rock walls rise to a height of about 900ft. above the river, and the gorge has a depth of about 125ft. below the water. The dam, forming an impounding reservoir of 26-million acre-feet, will be about 350ft. long at the low-water level and 880ft. on the crest. It will be a massive concrete structure of the gravity type, curved in plan, and the board of engineers has recommended that the maximum calculated stresses should not exceed 30 tons per square foot, although the original design called for 40 tons. Two rock-fill embankments will form cofferdams enclosing the site for the foundation work, the river flow being diverted temporarily through four or more tunnels 35ft. in diameter, providing sufficient capacity for floods of 200,000 cubic feet per second. Power development of 550,000 H.P. could be maintained even during years of low flow, and still allow ample supply for irrigation under present conditions; but irrigation developments may reduce that amount materially. The present irrigation canal lies partly in Mexico, but a new "All-American" canal is proposed. The estimated cost is £15,100,000 for the dam and reservoir; £7,600,000 for 1,000,000 H.P. development; £7,500,000 for the canal; and £3,540,000 interest during a seven-year construction period, making a total cost of £33,740,000.

Anti-friction Bearings for Heavy Machinery.

In a recent discussion on the subject of anti-friction bearings for heavy machinery, at a meeting of the American Society of Mechanical Engineers, both roller and plain or oil-film bearings had their supporters. Reference was made to a multiple-collar oiled bearing in a tube mill producing three tubes a minute, which had to be stopped frequently for renewal of the lining. Sometimes the mill ran only half an hour before renewal was required. Grease-lubricated roller bearings were substituted and stood for six months or more without adjustment. In the 14in. guns mounted for railway transport, the lower pintle thrust bearing has thirty-four balls 4in. in diameter in races 51in. diameter, all made of chrome-steel hardened and ground. The travelling weight is 730,000 lb., but each ball will stand a load of 100,000 lb. in the races without permanent deformation or surface cracks. Three essentials are: suitable steel properly made, proper heat treatment, and extreme precision in the final grinding finish. Turning the races 180 deg. at intervals to shift the loaded area, or making them with a creeping fit for this purpose, was advocated. Although roller bearings are claimed to be well adapted for rolling mills, there are difficulties in applying them to existing machinery owing to the limit of available space. Forced-feed grease lubrication of plain bearings in one such mill has eliminated the necessity of using water on the necks to keep them cool. In a test on a two-high rod mill, it required 95 H.P. without load and 170 H.P. while rolling when plain bearings were used. With roller bearings the power required was only 20 H.P. at no-load and 95 H.P. while rolling steel.

Boiler Drums for High Pressure.

In the 400,000 kW generating station at Deepwater, for the American Gas and Electric Company, the boilers are of the water-tube type, each with an effective heating surface of 9100 square feet and a capacity of 330,000 lb. of steam per hour. The entire boiler equipment is designed for a working pressure of 1400 lb. in the steam drums. These drums, forged from solid ingots, are 50ft. 3in. long, 4ft. 4in. inside diameter, and 5ft. outside diameter, with ends closed in dome shape and having manholes, the door for which are placed inside before the ends are drawn in to the finished manhole size. The open-hearth steel is of 75,000 lb. tensile strength, with elongation of 24 per cent. in 2in. and a reduction in area of 38 per cent. It has about 0·45 per cent. carbon, 0·30 to 0·45 manganese, 0·04 sulphur, and 0·04 phosphorus. The ingot is heated in a furnace, the bottom of which is mounted on wheels, so that the ingot can be run out within reach of the crane for handling. The forging or pressing to form and expand the hole and to shape and elongate the drum is done in a series of operations, but each operation can continue for only about half an hour, after which the forging is returned to the furnace to be reheated to the desired temperature. The drum is bored and turned to finished dimensions, after which it is returned to the presses for closing in the ends. In a hydrostatic test up to 2800 lb. pressure the drum expands about $^{3}/_{32}$in. in diameter and then returns to its normal diameter. The finished drum, weighing about 65 tons, goes then to the boiler works to be drilled for the tubes, safety valves and accessories.

Fire-box-First Locomotives.

To keep the engine cabs clear of smoke and gases on lines having many and long tunnels, the Southern Pacific Railway has equipped a number of its large "Mallet" engines to run with the fire-box and cab leading, the tender being coupled to the smoke-box end of the engine. The principal change is in making the cab with an enclosed end and in fitting the operating levers for convenient handling with the engineman having his back to the boiler head. The latest of these curious engines are of 4–8–8–2 type for service on a run of 140 miles with gradients of 1 in 40 and sharp curves. On account of the curves, wheel-flange lubricators are applied. The following are the leading particulars:—

Cylinders, four	24in. by 32in.
Valve gear	Walschaerts
Driving wheels	5ft. 3½in.
Leading bogie wheels	2ft. 9in.
Trailing bogie wheels	3ft.
Driving journals	12in. by 14in. and 11in. by 14in.
Wheel base, rigid	11ft. 4in.
Wheel base, driving	44ft. 7in.
Wheel base, engine	67ft.
Wheel base, engine and tender	106ft. 6in.
Weight on drivers	235 tons
Weight on leading bogie	43 tons
Weight on trailing bogie	26 tons
Weight of engine	304 tons
Weight of tender	140 tons
Fuel	Oil
Boiler pressure	235 lb.
Boiler, diameter	7ft. 8in.
Tubes, length	22ft.
Fire-box	196ft. by 102ft.
Combustion chamber, length	5ft. 8in.
Grate area	139 square feet
Heating surface, tubes	5992 square feet
Heating surface, fire-box and combustion chamber	513 square feet
Heating surface, total	6505 square feet
Superheating surface	2988 square feet
Tractive power at 70 per cent. cut-off	112,760 lb.
Tender, type	Cylindrical tank
Tender bogies	Six-wheeled
Water capacity	16,152 gallons
Oil fuel capacity	4860 gallons

Tramway Track Construction.

In the construction and reconstruction of American tramway lines there is increasing use of steel sleepers, embedded in a concrete base. These sleepers are of two types: shallow and deep. In the present standard design at Buffalo, flange rails 7½in. deep and weighing 102 lb. per yard, are secured by bolted clips to sleepers spaced at 6ft. centres, the rail joints being thermit welded. Each sleeper consists of a pair of 3in. rolled steel channels 3ft. apart, connected at each rail by a broad plate riveted across the top flanges. Thus the channels are at intervals of 3ft. in the track. The 11½in. concrete bed comes to about the middle of the rail webs, and is covered with a 1½in. bituminous concrete and a 2in. top course of asphalt, with a line of stone blocks outside the outer rails on double track, to separate the asphalt street paving from the rails. There are no defined grooves for the wheel flanges, but the paving is level with the bottom of the rail heads, and then arched or crowned so that at the middle of each track and of the space between tracks the paving is level with the tops of the rail heads. A somewhat similar construction is used at Cincinnati, but with brick, asphalt and concrete paving. At this city, however, the tracks in heavy-traffic streets are laid with deeper sleepers, resembling rolled joists, 4½in. deep and 4in. wide spaced 3ft. between centres. Bolted clips secure the 93 lb. 7in. T-rails, and are spot welded to the rails and sleepers. With asphalt paving, however, the rails are of grooved-head girder section, 7in. high and weighing 122 lb. per yard. Tile fillers are placed against the rail web, under the head.

INSTITUTION OF NAVAL ARCHITECTS.

The annual meetings of the Institution of Naval Architects will be held in the Lecture Hall of the Royal Society of Arts, John-street, Adelphi, W.C. 2, on Wednesday, Thursday, and Friday, March 20th to 22nd. The annual dinner of the Institution will be held on Wednesday, March 20th, at 7.30 p.m., in the Grand Hall of the Connaught Rooms. The following programme of proceedings has been arranged. On Wednesday, March 20th, there will be a meeting in the morning at eleven o'clock, at which, after the transaction of the usual business, the President—Admiral of the Fleet the Right Hon. Lord Wester Wemyss—will deliver his address. The following papers will then be read and discussed:—"H.M. Battleships 'Nelson' and 'Rodney,'" by Sir William J. Berry; and "Sea Trials of Italian Destroyers," by Lieut.-Col. F. Dondona, R.I.N.

On the Thursday the meetings will be resumed at eleven o'clock, when the following papers will be taken:—"The Propulsion of Ships by Modern Steam Machinery," by Mr. John Johnson; and "Some Considerations Regarding International Load Line Regulations," by Dr. J. Bruhn, D.Sc. At the afternoon session the following papers will be considered:—"New Results Obtained in Measuring Frictional Resistance," by Dr. G. Kempf, and "The Practical Use of the First British-built Bauer-Wach Exhaust Steam Turbine Installation in the Booth Liner 'Boniface,'" by Mr. C. F. A. Fyfe; while at the evening session, beginning at eight o'clock, Professor C. E. Inglis will present a paper on "Natural Frequencies and Modes of Vibration in Beams of Non-uniform Mass and Section;" and Mr. S. A. Hodges a paper entited "The Behaviour of Stiffened Thin Plating Under Water Pressure."

For the Friday morning the following papers have been arranged:—"Powdered Coal for Ships," by Engineer Rear-Admiral W. Scott-Hill, R.N. (Ret.); "Modern Developments of the Water-tube Boiler for Marine Purposes," by Mr. A. Spyer; and "Suggested Modifications to Marine Water-tube Boilers," by Engineer Rear-Admiral A. E. Hyne (Ret.). At the afternoon meeting Mr. J. Rennie Barnett will read a paper on "Motor Lifeboats of the Royal National Life-boat Institution."

THE INSTITUTION OF CIVIL ENGINEERS.

The annual banquet of the Institution of Civil Engineers was held in the Great Hall of the Institution on Wednesday last, with the President, Sir Brodie H. Henderson, in the chair. The principal guests were his Excellency Tsuneo Matsudaira, Japanese Ambassador; and Lt.-Col. the Right Hon. Wilfrid Ashley, Minister of Transport.

Mr. E. F. C. Trench, Past-President, gave the toast of "The Imperial Forces" in a short but very effective speech and Admiral of the Fleet Sir Charles E. Madden, First Sea Lord, in acknowledging it, outlined the system of training which was drawing the Army, the Navy, and the Air Force into closer harmony. The toast of "The Institution" was entrusted to Mr. Wilfrid Ashley. He outlined many of the great recent works of British civil engineers and averred that they could bear comparison, not only with the works of foreign engineers, but with the famous works of antiquity. A part of his speech, which was listened to with particular attention, was that in which he touched upon the Charing Cross scheme. He drew a picture of a remodelled area south of the Thames, in which Waterloo Station would at length be "discovered," and announced that agreement had so far been reached that Sir Edwin Lutyens had been invited to supervise the town planning of the whole scheme, but his influence would not extend to the bridge. He himself visualised a magnificent bridge with shops on it, but he was not sure that the technician would regard that as practicable. He held out a hope that within ten years or so the scheme might become a reality. The only other toast was that of "The Guests," neatly proposed by Sir John Snell and acknowledged by the Japanese Ambassador and Sir John Anderson, Permanent Under-Secretary of State, Home Office.

The Weston Fellowship in Electro-chemistry.—Dr. Edward Weston has established the Edward Weston Fellowship with the American Electro-chemical Society. The candidate will be selected by the Society and selection will be based on marked capacity in carrying out research in the science of electro-chemistry or its applications. The award will be made without distinction on account of sex, citizenship, race or residence. The successful candidate may carry out his research at any university or institute approved by the Society. The date of the first award—approximately 1000 dollars—is not definitely fixed, but will probably be in the autumn. Those interested should apply to the office of the American Electro-chemical Society, Columbia University, New York City. Dr. Weston was born in England in 1850, and is most widely known through the electrical instrument company which he established in Newark, N.J. He went to the United States in 1870, entering the employ of the American Nickel Plating Company.

The Institution of Chemical Engineers.—The seventh annual corporate meeting and annual dinner of the Institution of Chemical Engineers will be held on Wednesday, March 20th, next, at Grosvenor House, Park-lane, London, W. 1. At 12.15 p.m. the President, Sir Alexander Gibb, G.B.E., C.B., will deliver an address on "The Co-ordination of Engineering Institutions and Societies," and at 2.15 p.m. a paper entitled "Chemical Action in relation to Fatigue in Metals," will be read by Professor B. P. Haigh, M.B.E., D.Sc., M. Inst. C.E. Synopsis: "Mechanical fatigue" in metals is described and how the factor determining the limiting safe stress which can be repeated without causing brittle fracture is dependent on the chemical action of the medium surrounding the metal. Practical examples follow, illustrating the danger of such action and the means successfully adopted to overcome it. Laboratory researches to establish the laws governing conjoint chemical and mechanical action are also described, which show that the action may reduce the fatigue strength in ratio as high as even 8 : 1. A theoretical explanation is given of the conjoint action—which is distinct from ordinary corrosion—and its bearing on the general theory of fatigue is discussed. The annual dinner will take place in the Ball Room, Grosvenor House, W. 1, at 7 o'clock, Sir Alexander Gibb in the chair. The toast of "The Institution" will be proposed by the Right Hon. the Viscount Chelmsford, G.C.S.I., G.C.M.G., G.C.I.E., G.B.E., Chairman of the College Committee, University College, London,

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Momentum Maintained.

THE gradual improvement in the aggregate volume of business passing in the iron and steel and heavy engineering trades of the Midlands and Staffordshire continues, and now that the British Industries Fair is at an end, manufacturers are again turning their attention to raw materials. On 'Change in Birmingham to-day—Thursday—there was a good attendance, and business proceeded quietly. The upward trend of prices persists, and the uncertainty in regard to future values compels consumers' interest. Many of them considered it wise to increase the size of their orders, and some negotiations with respect to forward contracts were spoken of. Buyers have exercised so much caution during past months, and have, in the main, bought so sparingly that they appear almost to have lost the old sense of proportion, and, although buying has been indulged in with more freedom this week, the tonnages negotiated compare very unfavourably with those that producers were accustomed to receive orders for in normal times at this season of the year. They are, however, an improvement on those of recent months, particularly in the steel department, in which consumers, daily discovering increased difficulty in getting deliveries of suitable foreign steel at the right price, are coming to realise the necessity for securing themselves and keeping up regular supplies of raw material. With that end in view, and being of the opinion that the chances of obtaining very cheap continental steel in the near future are becoming more remote, they are placing orders with local steel masters before prices are raised further. They have accepted the penalty of remaining free to buy in either the home or foreign market, and they fear that should the stringency in continental material become more severe, this penalty of proportionately higher prices than those relating to exclusively British steel users may be increased. There seems every prospect of the demand for iron and steel advancing in the next few months, for reports from the various industries in the Midlands nearly all appear satisfactory. Though outside engineering works have been held up by the severe weather, there is increased activity in other branches. Makers of heating apparatus, for instance, have been working at heavy pressure, and sanitary engineers also have been exceedingly brisk. Foundries have a fair amount of work and some firms have been busily employed in casting for the general engineering industry. Firms in the casting trade in the Black Country anticipate a steady demand for the next few months. Automobile engineering firms are busily engaged, and a large proportion of the Birmingham, Coventry and Wolverhampton factories are working to capacity. Rolling stock establishments are favourably placed, and while the heavy engineering section is, on the whole, quiet, the electrical section is better employed than it was. Machine tool makers are better placed than they were some time ago, and the installation of new plant is providing a certain amount of work. The tube trade is quiet, but the hollowware trades show improvement. Reports from the shipyards are encouraging, and Black Country manufacturers of chains, cables, anchors, and ships' fittings welcome the definite symptoms of more activity in an industry the prosperity of which is so closely allied to their own. They hope for some useful business from this source in due course.

Steel.

The advantages recently accruing to local steelmasters as a result of high continental prices and delayed deliveries of foreign material continue. Indeed, they are being extended, few offers of foreign steel being forthcoming, whether for semis or finished products, with the result that consumers are placing more and larger orders at home. Some Midland steel works are finding fairly regular employment and similar reports are to hand from other districts. The steel market is accordingly gaining strength, and although up to now no change has been made in the basis price of finished material, a readjustment of values at no distant date would not occasion surprise. The fixed prices for joists and angles at £7 17s. 6d. and ship, bridge and tank plates £8 12s. 6d. still rule. The basis for Staffordshire hoops remains at £10 at works, while boiler plates are named £9 15s. Business is more lively in the half-products branches. Small steel bars are generally quoted £8, and only an attractive line would tempt sellers to take less. English billets for sizes over 2in. now cost £6 7s. 6d. and for 2in. £6 10s. There is a better inquiry for sheet bars, which are firm at £6 7s. 6d. though it might be possible to arrange business at £6 5s. Continental quotations are difficult to obtain, but the prices ruling since the beginning of the year in most cases are maintained. Billets, however, are dearer, and are not obtainable under £6 5s., delivered in this district. There is a good demand for scrap, which is scarce, and buyers in South Wales are willing to pay £3 12s. 6d. delivered that area.

Staffordshire Iron.

The all-round improvement of the past few months in the Staffordshire finished iron trade is maintained, but the majority of the mills require more work to keep them regularly employed. Fortunately, makers of marked bars continue to book orders, and work at these mills is fairly steady. Staffordshire ironmasters have not yet advanced the price of marked bars, which remain at £12 per ton, a figure which has applied for the past eleven months. But in view of the increasing cost of raw materials there is every prospect of a rise in order that makers may be compensated. Some makers, however, are fortunately placed with regard to pig iron supplies, having laid in stocks when prices were low. The Crown bar mills continue their efforts to obtain a few shillings more for their iron. Lancashire works have already declared an advance of 10s. in their Crown bars, making the price £10 10s. Their quotation applies to the Lancashire district only, but there is almost certain to be some reaction on prices in other districts. In Staffordshire the little improvement in this branch noted some time ago is maintained, though the mills could easily handle much more business. The nut and bolt makers at Darlaston are depressed, and are not ordering much in the way of iron or steel bars. The orders, however, are now frequently placed with local mills, partly because of the dearness of foreign material, but also on account of the difficulty in obtaining delivery. Wrought iron gas tube strip sells freely, the price being unchanged.

Galvanised Sheets.

Inquiries for galvanised sheets have slackened to some extent, but manufacturers have no anxiety for the immediate future, and have made no alteration in the basis price of £13 12s. 6d. to £13 15s. for 24 gauge corrugated sheets. It is considered to be only a temporary lull. Demand, it is confidently anticipated, will have become reinvigorated long before the mills are in need of orders. Values of lighter gauge sheets are likewise unchanged from recent levels.

Pig Iron.

Consumers of Northamptonshire pig iron continue to refrain from purchasing material, except in cases of urgent need, at the new rate demanded by smelters. The latter, however, are firm in their attitude, and there seems every prospect of buyers being compelled to reconcile themselves to the new position. There is no great excess of output over demand, and stocks at furnaces are not unusually large. Moreover, as blast-furnacemen contend, the recent advance in price only puts Northamptonshire material in its usual relationship to Derbyshire prices. The figure of £2 19s. for No. 3 foundry material, it is claimed, permits of no more than a fair margin of profit, especially taking into consideration the dearness of furnace coke. Derbyshire foundry material is quoted £3 2s. 6d. and business is slightly better, though still of a hand-to mouth character. Midland smelters are reported to be securing a certain amount of orders from steel firms in the Cleveland area, who are unable to obtain adequate tonnages of Cleveland iron. Foundrymen in the Birmingham area are more evenly employed and are constantly watching the buying position, but hesitating to place forward contracts. Little interest is displayed in the forge branch, while the orders put through are insignificant. Quotations are unaltered from last week.

Blast-furnace Coke.

There is a considerable scarcity of blast-furnace coke, and local smelters find it almost impossible to obtain supplies from Yorkshire unless the subject of contracts. Derbyshire furnace coke is obtainable, but only at the advanced price of 14s. 6d. per ton at ovens. Indeed, ovenmen are now asking this figure for new contracts. It represents a marked rise over the figure at which many Midland furnacemen placed their previous contracts. The dearness of coke is naturally influencing smelters in their firm attitude regarding pig iron prices.

B.I.F. Orders for Machinery.

In my letter last week I referred to the satisfaction expressed by Midland engineers with the manner in which business was shaping in their section of the British Industries Fair at Castle Bromwich. The second week's negotiations further increased this contentment, and at the close of the Fair it was recorded that in the engineering section many satisfactory orders had been booked. Considerable business is also expected to develop in the near future as the result of the Fair, and, if inquiries made at the stalls are anything to go by, Midland engineering firms should have a busy and prosperous year.

L.N.E.R. Order for Shrewsbury.

The London and North-Eastern Railway Company, which already has some forty to fifty Sentinel Camel railway coaches in use on its system, has presumably found them so useful in maintaining frequent services and in competing with omnibus traffic on suburban routes that it has placed an order for a further thirty-one of these coaches. The Sentinel Waggon Works at Shrewsbury are at date busy turning out rail and road vehicles, including a large proportion of six-wheelers, and they are being congratulated on their latest rail success.

Miners' Wages—Coal Profits.

Cannock Chase and Pelsall miners' wages for March are to remain on the same level as has operated during the past nineteen months, namely, at 42 per cent. on the 1911 basis. This gives to stallmen a minimum of 9s. 4d. per day. Based on costs during November, December, and January, the ability of the industry to pay is 34·91 per cent., which is a big improvement on previous returns, comparing as it does with 25·83 per cent. in February and 21·62 per cent. in January. Another very satisfactory feature is the fact that in January there was a profit of 2s. 2·44d. on every ton of coal raised in the area. After months of producing at a loss, coalowners welcome this turn in the tide, though it is hardly expected to be permanent, the better position being attributed to the increased demand for domestic coal as a result of the recent very severe weather. The owners' total accumulated deficiency now stands at £2,851,229, and the actual deficit since the local agreement was signed at the end of 1926 is £938,409. There is a brisk demand for coal in the district, and the majority of the collieries are working full time.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Industrial Prospects.

CONDITIONS in the various branches of the engineering industry in this area are summed up in the current monthly bulletin of the Manchester Chamber of Commerce as follows :—"Textile machinists have again had a varied experience, some having their works fully employed, while others have had to fall back upon short time. New orders for artificial silk machinery have come to hand, and this section continues to be well engaged. Looms have been wanted for export, but the home demand has been small. Electrical engineers who make heavy plant have been well engaged, constructional engineers have done fairly well, motor car and vehicle manufacturers have had a good deal of work, and machine-tool makers generally have been busy. Boilermakers, also, have had a larger business." It will be observed that conditions in the textile machinery branch have not been too satisfactory on the whole. There are indications, however, that the position is improving somewhat, although, as before, firms in this branch have to depend largely upon foreign markets for their orders. One Manchester firm of machinists has just secured a substantial order for the plant equipment of a new Japanese cotton mill, whilst an engineering firm in Oldham engaged largely in the same branch has, after a period of curtailed operations, gone back to full-time working, with the prospect of continuing in that satisfactory position for several months at all events.

Electrical Engineers and Electricity Act.

Producing as they do a wide range of engineering products—electrical machinery, textile plant, pumps, fire-fighting equipment, and general products—the chairman's address at the annual meeting of Mather and Platt, Ltd., of Newton Heath, Manchester, is usually of wide engineering interest. Reporting a slight increase in the company's profits for the past year compared with 1927, Mr. Louis E. Mather, who presided, said that their total sales of electrical machinery for 1928—dynamos and motors, geared generators and converting plant—as regarded numbers sold, manufactured, and delivered, constituted a record in the history of the company. Up to the present, Mr. Mather pointed out, the benefits which electrical manufacturers should derive from the Electricity Act had not yet been felt to any great extent, but they were looking forward to an increased demand for standard machines as cheaper electrical power became more widely distributed.

Engineers' Markets Overseas.

Mr. Mather was somewhat cautious as to prospects at home during the present year, but, on the whole, his review of the outlook in the overseas markets was hopeful. Progress continues to be made in those countries where conditions are fairly normal, favourable results having been experienced in France, Germany, and Central Europe, whilst in Russia prospects are regarded as being more promising. More business, especially in textile machinery, is being obtained in Canada. Japan is a good customer, in China prospects are improving, and India continues to provide many inquiries. Particular stress was laid on the importance of the South American markets—Brazil and Argentina—which are regarded as being potential fields for the products of British engineering firms, and it was explained that a careful study was being made on the spot by a special director of the company of the future engineering requirements of Argentina.

Liverpool's £1,760,000 Scheme.

An electricity scheme which the Liverpool Corporation has in view promises to provide considerable work for engineers in the near future. This refers to the acquisition of the Clarence Dock site and the erection of an electricity generating station, with a capacity of 100,000 kW, at an estimated cost of £1,760,000. Sanction to raise this sum is being sought from the Electricity Commissioners. Alderman F. C. Wilson has been elected chairman of a special sub-committee which is in charge of the scheme, and Mr. Lawrence Holt vice-chairman. It is expected that the work will be begun in two or three months, and that it will take three years to complete. The work will, of course, form part of the scheme for North-West England and North Wales, which is estimated to cost in the aggregate about £9,000,000.

Non-ferrous Metals.

Operations on the non-ferrous metals markets during the past week have provided evidence in plenty of the strength of the copper market, but evidence, also, of a position which is far from healthy from the point of view of industrial consumers of the metal and one which is by no means free from speculative influence of a very pronounced character. Following upon the previous week's advance of about £3 a ton, prices have been run up a further £4, quotations for standard cash metal being in the neighbourhood of £3 a ton, higher than they were a month ago, when the peak of the previous rise was touched. In view of the fact that speculation is now rampant in this section of the market, the immediate outlook is anything but certain, and the probability of a swing of the price pendulum in the opposite direction as a result of profit-taking must not be lost sight of. As it is, quotations at the moment of writing are fractionally below—about 2s. 6d. a ton—those current last week-end. Overclouded as it has been by copper, interest in tin has been relatively slow, and buying for industrial consumption has been quiet. Although there has been only a very slight loss on balance for the week, the tendency of prices in this section is still rather easy. In the case of lead the market has been distinctly firm under the influence of a free buying movement, and values have undergone a further rise of 5s. a ton. A somewhat better demand has been experienced for spelter, and quotations for this metal have shown a slight gain on the week.

Iron and Steel.

Sales of foundry iron locally have been on a slightly improved scale since my last report, and with contract deliveries satisfactory, makers are able to maintain without much difficulty the higher level of prices. For delivery to users in this area Derbyshire No. 3 iron is quoted at 70s. 6d. per ton, Staffordshire at 72s. 6d., Middlesbrough at about 80s., Scotch at from 88s. to 90s., according to brand, and hematite at 84s. 6d. to 85s. The demand for manufactured iron is only of moderate extent.

with values, as reported a week ago, firmer at £10 10s. per ton for Lancashire Crown quality bars, and £10 for seconds. Possibilities of dearer steel within the near future have been freely canvassed here during the past week and consumers in the heavy branches have not been slow to take precautionary measures. In contrast with the conditions that have existed for so long and almost without interruption, there has been a relatively good weight of contract buying by constructional engineers to cover themselves well ahead. It is probable that very little of this increased buying is due to any fundamental improvement in the order books. There has been rather more demand about for general plates, though still largely of a hand-to-mouth character, and boiler plates, also, have been more freely specified for delivery against existing contracts, principally for the locomotive building industry. Re-rollers are asking 5s. per ton more for small bars, current values ranging from £8 5s. to £8 7s. 6d., according to quantity. Boiler plates are maintained at £9 17s. 6d. per ton for acid quality, and 5s. less for basic, as are also joists at £7 17s. 6d., large bars at £8 17s. 6d., and tank plates at £8 12s. 6d. per ton.

BARROW-IN-FURNESS.

Hematite.

There has been a slight hesitation on the part of buyers. It is, however, not due to a falling off in demand, but is owing to the improvement in price for hematite pig iron. It is expected that it will only be momentary, as it is possible that the price may further stiffen in the near future. A good feature is that stocks are coming down, and it will not be long before they are cleared, apart from parcels awaiting orders for delivery. The trade with the Continent continues to be steady, and orders are regular, although the tonnage is not heavy. American business varies, but there are prospects of further movements. The fact that the steel departments in Barrow and Cumberland take a fair amount of iron each week does not leave a great margin with some firms, and as soon as stocks are cleared there may be more furnaces put in blast. The iron ore trade is a little better, for, apart from a slightly better demand locally, there is more trade being done with smelters outside the district. Foreign ore is in steady demand. The steel trade might be better, but the mills are still engaged upon railway material, some of which is on the London, Midland and Scottish account.

SHEFFIELD.

(From our own Correspondent.)

Steel Trade Outlook.

THERE are several bright features in the condition of the local heavy industries. One of the chief of them is that manufacturers are finding themselves in a position to compete with the Continent on more favourable terms than for some time past. The increase of foreign costs of production, and the realisation of buyers that quality is as important as the first cost of materials, are bringing more work to the district. Material, which had until recently been imported, is now being made at home, and the output of steel is steadily increasing. The improvement is chiefly in the departments concerned with crude basic steels, cold-worked steels, motor steels, special forgings and castings, and there has only been a very slight advance in the call for acid steel, in connection with which conditions remain quiet. Several additional open hearth furnaces have been put into operation this week, however, and more steel is now being produced by such firms as Vickers and Cammells than was the case at the end of last year, whilst at Templeborough and Parkgate the melting plants have been fully occupied for a considerable time. The absence of work for the railways is still being felt rather keenly, and it is not expected that there will be any substantial improvement in the acid steel departments until railway buying is resumed.

Iron and Steel Scrap Boom.

The condition of the market for iron and steel scrap indicates very clearly the position in the steel trade generally. For some time past there has been a very heavy call for this scrap, and the scarcity of metal for remelting purposes has resulted in prices for basic quality scrap soaring. When it is realised that something like 40 to 60 per cent. of the charge of a furnace consists of scrap, it can be understood that the costs of steel production are very appreciably affected by the high cost of that material. Most Sheffield firms are, however, concerned in the manufacture of high-quality steels, and the state of that trade is reflected in the fact that prices for scrap suitable for acid steels are still fairly easy.

Contracts for Submarines.

Sheffield is interested in the contracts placed last week by the Admiralty for five submarines and two sloops. Cammell Laird's and Beardmore's have each received an order for one submarine, and three of the new "P" submarines are to be built at the Barrow shipyard of Vickers-Armstrongs. It is stated that the "P" type of submarines are modifications of the "O" type, the displacement of which ranges from 1300 to 2000 tons, and which carry one 4in. gun in an armoured position.

British Industries Fair.

There was a good show of Sheffield products at the British Industries Fair, and although the business done was not great, it is hoped that the display will have a beneficial effect from an advertising point of view. For instance, the exhibition of the newer alloy steels, stainless steels, and special case-hardening steel was impressive, and visitors could not help being struck by the great variety of purposes for which the newer alloy steels have been found suitable.

Cutlery and Plate Trades.

Conditions in the cutlery and plate trades remain unchanged, and there are no signs of any general improvement upon last month when the output was disappointingly small. Several Sheffield firms booked good orders at the Fair, but competition for large contracts is very keen. Business in stainless steel articles continues to expand steadily, and there is some improvement in the demand for the higher grade plate and cutlery products, but the call for ordinary qualities of cutlery for the retail shops is very weak. So far as pen and pocket knives are concerned, there is a fair demand for the good quality article, but many firms are desperately short of work. For safety razor blades there is a large and increasing call, and good business was done at the Fair.

Advertising Sheffield.

The suggestion that Sheffield manufacturers, whether in the heavy industries or the light, should pay more attention to advertising their products and making their qualities more widely known, has often been made and considered without any practical result being forthcoming. It has now been suggested that the local Chamber of Commerce should organise some permanent exhibition, but with regard to this proposal, the Chamber states: "We feel that this is a matter which is primarily the concern of the actual firms in each separate trade, who are best able to decide what would prove suitable. The cost would not be heavy, divided amongst all the firms concerned, and on the whole we believe that such a project is well worthy of full investigation."

Water-softening Plant.

The new water-softening plant of the Mexborough Council, which has just been opened, is designed to deal with half a million gallons per day, and water, after passing through two steel cylinders and being treated with chemicals, has its hardness reduced by 20 deg. The new plant, it is hoped, will solve the long-standing problem of Mexborough's water supply. It was made necessary because the water obtained after the acquisition of the Ludwell Springs last year was too hard.

Hull Level Crossings Scheme.

Some disagreement has arisen between the Hull Corporation and the London and North-Eastern Railway Company with regard to details of the scheme for the abolition of the city's level crossings that is to cost £1,250,000, of which the Corporation is to bear half and to which the railway company has agreed to contribute £100,000. The original plan provided for the abolition of the city's ten level crossings, five of which are across main traffic arteries. The railway company, however, wishes to preserve the Hessle-road level crossing, and the Corporation is determined to stick out for the abolition of it along with the others, contending that with the opening of the new Boothferry Bridge, all the road traffic from the West Riding and Midlands will have to enter the city by way of that road.

Sea Defence Works.

A scheme for the erection of sea defence works has been prepared by the Withernsea Council, and a Government inquiry into it is to be held. Erosion of the coast near Withernsea is taking place at a very rapid rate, and the scheme includes provision for new groynes and promenades to the north and south of the present sea walls. It is estimated that the cost of the works will be about £25,000.

Colliery Developments.

The improvement in the coal trade has been so great that many collieries are finding difficulty in meeting the demand. It is reported that important developments are contemplated at the Cortonwood Colliery, where the Silkstone seam is to be reopened, and it has been stated that at the new Bilsthorpe Pit of the Stanton Ironworks Company, Ltd., the output of which has reached 1400 tons a day, it is expected that eventually production will reach 14,000 tons daily.

NORTH OF ENGLAND.

(From our own Correspondent.)

Industrial Developments.

FURTHER industrial developments are foreshadowed on the north bank of the river Tees. It is understood that Imperial Chemical Industries, Ltd., has been negotiating for some months past with the Tees Conservancy Commission with a view to acquiring 200 acres of land east of Port Clarence for new chemical works. The River Tyne Commissioners were hopeful that the new project would be undertaken in their area, but facilities on the Tees, where much valuable foreshore near the sea awaits development, secured first consideration. If carried through to fruition on Tees-side, the Imperial Chemical plans are understood to be of so far-reaching a nature as to enhance to a most important extent the industrial potentialities of the river Tees. One leading branch of this great chemical combine, Synthetic Ammonia and Nitrates, Ltd., is already established at Billingham-on-Tees, where employment is found for about 12,000 men. Recently, Synthetic Ammonia and Nitrates, Ltd., obtained a large area of foreshore from the Tees Commissioners as the site for a new private dock at Billingham.

New Tees Bridge.

The plans for a new bridge over the river Tees at Newport have been formally approved by the Tees Conservancy Commissioners, conditional upon the span being increased by 50ft. The consulting engineer, Colonel A. J. Barry, after examining the plans and report of the bridge engineers, advised the Commissioners that provided the pier on the Yorkshire side of the river was moved shorewards for a distance of, say, 50ft., making a clear opening width of 250ft. between the piers, no reasonable objection could be raised against the construction of the bridge. The Middlesbrough Corporation, the Durham County Council, and other authorities on the banks of the Tees are co-operating in the project, which is estimated to cost £500,000.

Iron and Steel Exports and Imports.

The exports of iron and steel from the river Tees during February totalled 91,300 tons—the highest monthly total recorded since December, 1927. Pig iron shipments declined from 18,851 tons in January to 14,915 tons in February, both coastwise and foreign shipments being reduced, owing to the scarcity of pig iron supplies in the Cleveland district. There is, however, a healthier demand and every prospect of expansion when supplies are available. The exports of manufactured iron and steel during February reached 76,385 tons, as compared with 62,319 tons in January, the outstanding feature being the heavy dispatches to South and East Africa. To the Cape alone 12,562 tons of manufactured iron and steel were shipped, and the total of 21,959 tons to South and East African ports is the heaviest in the history of Tees trade. India, Ceylon and Burmah also took 17,484 tons, the Argentine 13,551 tons, and Australia 4500 tons. On the other hand, imports continue to decline. Statistics presented at this week's meeting of the Tees Conservancy Commission showed that during the past four months the imports of iron and steel from foreign countries totalled 62,345 tons, as compared with 72,204 tons in the corresponding period of 1927–28, and 22,269 tons in the pre-war period of 1913–14. Pig iron imported during the four months reached 17,248 tons, as against 3561 tons and 54 tons; plates, bars, angles, rails, sheets, joists, &c., to 11,050 tons, as compared with 14,950 tons and 7906 tons; crude sheet bars, billets, blooms, slabs, &c., to 34,947 tons, as against 53,693 tons and 14,509 tons.

Cleveland Iron Trade.

A feature in Cleveland iron trade circles this week is the news that makers have been successful in recovering the half-yearly contract for supplies of pig iron from the Scottish Light Castings Association. Six months ago the Midland makers secured the order for the first time for many years at prices much lower than those of Cleveland makers. During recent weeks Mildand prices have advanced by several shillings, though it is believed to be more a question of quality of iron than price that has induced the Association once more to place its order in the Cleveland district. The contract involves about 30,000 tons of pig iron. The Cleveland market is very active. With increasing confidence in the future, consumers are showing more and more desire to negotiate for forward supplies, and producers could enter into heavy contracts for delivery over periods ahead if they would accept quotations now ruling. Indications of an early upward movement in values are, however, somewhat marked, and consequently makers are disinclined to sell extensively at current market rates. They are reluctant to advance prices, but their hands may be forced if raw materials keep advancing. Both coke and ore are dearer this week. Moreover, there is a scarcity of pig iron, particularly basic qualities. Stocks of most descriptions have vanished, and an early enlargement of the make seems essential. No. 1 Cleveland foundry iron is nominally 69s. 6d.; No. 3 G.M.B., 67s.; No. 4 foundry, 66s.; and No. 4 forge, 65s. 6d.

Hematite Pig Iron.

East Coast hematite pig iron production is quite inadequate for requirements. Terms of contract vary a good deal, but it is now difficult to buy on a lower basis than 73s. for ordinary qualities, and more is stated to have been paid.

Ironmaking Materials.

The value of best Rubio ore is now put at 22s. 9d. to 23s. per ton c.i.f. Tees, and very limited supplies of foreign ore are available. Industrial coke is also scarce and dear, 18s. 6d. per ton now being a minimum delivered price for good medium blast-furnace qualities.

Manufactured Iron and Steel.

There is a steady increase in the activities of the manufactured iron and steel works, though maximum output has not been attained. Local consumers have practically ceased to buy foreign semi-finished steel, and orders are being diverted to local works. Steel makers are also getting a bigger share of the trade in markets overseas. Prices are unchanged, but distinctly firmer.

The Coal Trade.

The Northern coal trade retains all its recent strength, and the only thing the collieries regret is that they have not more fuel to offer. The milder weather is expected to cause a slackening off in the demand from some continental centres, but definite bookings already held by the fitters for every grade of coal are ample to clear the market of the entire output, even allowing for increased production by the opening out of other pits or extended workings. For this month's delivery sellers have only odd lots for clearance, and ask full recent prices. For April, the tone remains firm, but there is a disposition among operators to mark time until the weather vagaries have time to affect the market, as should continental internal waterways navigation improve rapidly to normal, it would allow coals from many European centres to come again into competition with British supplies. Fitters, however, retain a very hopeful view of April prospects. If they had more coal to dispose of for spot, they could doubtless obtain higher prices for it than those indicated by current quotations. Up to 17s. 3d. has been named for prompt delivery of best Blyth steams, whereas the nominal figure is 16s. 6d. Steams are in great demand, both for large and small. Special Durham gas coals are scarce for all this month, and are firmly quoted at 15s. to 15s. 6d. Secondary gas coals are firm for prompt and steady forward at 14s. 6d. to 15s. Durham coking unscreened coals are offered at 14s. 6d. to 15s. 6d., according to quality and shipping dates. There is a quiet bunker trade demand for steamers' use, but the coaling stations' demands are expanding, and prices are quoted steady, best and special qualities

being 15s. to 15s. 6d., and ordinary 14s. 6d. There is a steady pressure for all classes of coke, and prices are well maintained.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

THE output from Clyde shipyards during the month of February constituted a fair average for the month, the total being 34,830 tons. A year ago outputs were heavier, but work on hand was diminishing rapidly, and in this respect the position at present shows a decided improvement, despite a comparative lull in fresh business during February this year. The largest vessel launched last month was the "Athelduchess," motor tanker, twin-screw, of 9000 tons, built for the United Molasses Company. Of the others most interest centred in the submarine "Orpheus," launched by Wm. Beardmore and Co., Dalmuir, Glasgow. Contracts placed during February included two 13,000-ton motor tankers, two destroyers, and a submarine.

Steel.

Specifications for steel plates and sections are comparatively frequent at present, and most establishments are fairly busy. Sheet makers have good orders, but thin sheets are not quite so prominent as usual. Galvanised sheets are only moderately busy. The scarcity and consequently enhanced price have forced steelmakers to use a larger percentage of pig iron and less scrap. Prices of steel are all firm.

Iron.

The position in the bar iron trade is still unchanged. The majority of the works are idle, and those in operation are busy. Prices are firm. Makers of re-rolled steel bars are busy, and prices have been raised to a minimum of £8 per ton owing to the enhanced costs of continental semis. Pig iron is quiet and featureless.

Exports.

During the past week exports of steel and iron from Glasgow Harbour totalled 5709 tons and consignments of pig iron 558 tons.

Tubes.

Tube makers report a continuation of recent activities, more especially in the butt-welded and hot-rolled descriptions.

Manufactured Copper Advanced.

The price of manufactured copper has been advanced by £2 per ton, making the quotation for strong £116 per ton basis.

Coal.

The Scottish coal market continues firm and unchanged. More pits have been restarted, but so far the effect on supplies is hardly noticeable. Foreign demands have dwindled owing to the impossibility of securing sufficient quantities of prompt fuel, and the disinclination of foreign importers to pay current prices for forward delivery. Home demands are well maintained owing to weather conditions. Collieries in all districts are well booked up, in some instances well into the month of April. Some idea of the scarcity of coal may be derived from the fact that during the month of February operations at steelworks were frequently interfered with owing to a lack of sufficient fuel. Trading delays have been met with owing to vessels being thrown out of position. Aggregate shipments amounted to 225,549 tons, against 226,199 tons in the preceding week, and 219,693 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THE position in the steam coal trade continues to be good, and there is now no question about collieries having a brisk time right up to the Easter holidays. It will, in fact, be surprising if considerable activity is not seen for several months to come, though perhaps the pressure may not be quite equal to that which now prevails. The continued interruption of the free transport of continental coals owing to the cold weather is still beneficially affecting business in coals from this district, but even allowing for this factor, there is reason to believe that trade generally is better, because the demand for cargoes is widespread. It is also singular, though by no means a new experience, that many buyers abroad show more readiness to operate when coals are moving upward in price than when the market is depressed. Although no especially big inquiries are in circulation, the demand for single cargoes is fairly active. Many collieries are already well booked up into April, and best Admiralty large coals are quoted at 20s. 6d. to 21s. One of the best features is the fact that the chartering of tonnage has been very brisk. For the week ended the 1st inst. it is reported that the quantity of tonnage taken up was over 414,000 tons, which is the largest total since the middle of November last. It is indeed well above the average for any previous week this year. Quite apart from fixtures which are reported, there is a good deal of chartering which does not become known on the market. On Thursday of last week the activity in outward chartering was exceptional, over 120,000 tons being taken up for loading in this district. Operations continue on a steady basis, so that the outlook for the trade is very promising.

Result of Extra Working Hours.

A plentiful supply of tonnage and a little extra working at the docks are presumably responsible for the good results achieved last week in the matter of shipments. According to returns issued by the Great Western Railway Company, the total shipments for the week ended the 3rd inst. were 641,144 tons, which compares with 539,366 tons for the previous week. Last week's total is, in fact, the highest for any week since May, 1927, and includes coal and coke, bunkers and coastwise shipments, as well as exports to foreign countries from docks in this district under the control of the Great Western Railway Company, so that shipments from Llanelly and elsewhere are not included. The good work which was accomplished at the docks last week had the effect of materially reducing the excess of tonnage waiting to load. As recently mentioned, the docks were considerably congested owing to tonnage being held up by the recent severe weather, but on Saturday last there were only thirty-six steamers waiting to load at South Wales ports, while five tips were idle. Since then the position has been rendered easier, as on Tuesday there were only twenty-four steamers waiting for a berth and six tips were idle. It will therefore be seen that the loading conditions are now becoming something like normal. To ensure the continuance of good work and quick despatch, there is no doubt that coal-owners and coal exporters would like to see an extension of the arrangement for extra work. The agreement recently come to whereby the existing shifts are extended by two hours terminates on Saturday, and at the moment of writing there appears to be some doubt as to whether the men are to be asked to continue the arrangement. There is a feeling that this should be done, and no doubt a meeting will be held towards the end of this week to decide the matter.

Tin-plate Pooling Scheme.

Instead of the existing scheme for the restriction of output, whereby mills have been closed down for three weeks out of thirteen, a new arrangement is to operate. At a conference of the tin-plate trade at Swansea on Monday, it is understood that the decision was come to for the adoption of a scheme which involves the pooling of orders, so that works will in future receive an allocation in accordance with their output capacity.

Current Business.

The market for all descriptions continues to be firm, especially for prompt loading. Reports are current that in some instances as much as 21s. to 22s. has been paid for small parcels of superior large coals. Such figures indicate the strength of the market, though they are above what can be secured for business ahead. Still the outlook is good and salesmen are declining to accept less than 20s. 6d. for best Admiralty large coals for delivery over the next few months. Over 20s. has been paid for second Admiralty large coals, while in the case of superior smalls the market is about 14s. to 14s. 6d. for supplies for early shipment. Coke is firm but patent fuel remains without much alteration. Pitwood has been a variable market. As the result of the news on Thursday of last week of a strike of workmen at Bordeaux the market rose from about 25s. 3d. to round about 28s., but on Saturday last it was announced that the strike was over, so that since then the price has fallen to about 27s. to 27s. 6d. per ton.

LAUNCHES AND TRIAL TRIPS.

ASNI, single-screw steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Compagnie de Navigation Paquet, of Marseilles; dimensions, 340ft. by 43ft. beam. Engines, triple-expansion; constructed by the builders; launch, February 11th.

MOPAN, single-screw steamer; built by Cammell Laird and Co., Ltd., to the order of Elders and Fyffes, Ltd.; dimensions, 400ft. by 51ft. by 32ft. 11in. Engines, triple-expansion reciprocating, 27½in., 46½in., 78in. diameter by 54in. stroke, pressure 210 lb.; constructed by the builders; launch, February 13th.

AZTEC, single-screw steamer; built by Barclay, Curle and Co., Ltd., to the order of the Cuyamel Fruit Company, of New Orleans; dimensions, 405ft. by 53ft. 2in. by 33ft. 6in. Engines, four-cylinder triple-expansion, 30½in., 51in., 62in., 62in. diameter by 48in. stroke, pressure 200 lb.; constructed by the builders; launch, February 14th.

HOPEMOUNT, motor oil tanker; built by Swan, Hunter and Wigham Richardson, Ltd.; dimensions, 465ft. by 61ft. by 32ft. 3in.; 11,000 tons deadweight. Engine, six-cylinder, single-screw, reversible, single-acting, two-stroke cycle oil; constructed by the Wallsend Slipway and Engineering Company, Ltd.; trial trip, February 14th.

TOLTEC, single-screw steamer; built by Barclay, Curle and Co., Ltd., to the order of the Cuyamel Fruit Company, of New Orleans; dimensions, 405ft. by 53ft. 2in. by 33ft. 6in. Engines, four-cylinder triple-expansion, 30½in., 51in., 62in., 62in. diameter by 48in. stroke, pressure 200 lb.; constructed by the builders; trial trip, February 14th.

ANDUTZ-MENDI, steamer; built by Wm. Gray and Co., Ltd., to the order of La Compania Naviera Sota Y. Aznar, of Bilbao; dimensions, 289ft. by 39ft. by 18ft. 2½in.; to carry cargo. Engines, triple-expension, 20½in., 33½in., 55in. and 39in. stroke, pressure 180 lb. per square inch; constructed by Central Marine Engine Works of the builders; trial trip, February 18th.

IERE, steel oil coaster; built by Smith's Dock Company, Ltd., Middlesbrough, to the order of Trinidad Leaseholds, Ltd.; dimensions, 180ft. by 33ft. by 17ft. 6in.; to carry bulk oil and part case oil. Engines, triple-expansion, 13½in. by 23in. by 37in., pressure 180 lb. per square inch; trial trip, February 19th.

JOSEPH P. BURKE, single-deck screw steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Mr. J. J. Boland, junr., and Captain R. Scott Misener, Canada; dimensions, 263ft. by 43ft. 4in. by 20ft.; to carry 2585 tons. Engines, triple-expansion, pressure 180 lb. per square inch; constructed by the builders; launch, February 21st.

BRITISH CHIVALRY, oil tank steamer; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of British Tanker Company, Ltd.; to carry 10,000 tons. Engines, quadruple-expansion; constructed by the builders; trial trip, February 26th.

GLASGOW, twin-screw motor vessel; built by A. and J. Inglis, Ltd., Glasgow, to the order of Argentine Navigation Company (Nicolas Mihanovich), Ltd.; dimensions, 275ft. by 43ft. by 13ft. Engines, two six-cylinder four-stroke trunk type Diesel engines; constructed by Harland and Wolff, Ltd.; launch, February 26th.

BRITANNIA, passenger steamer; built by Swan, Hunter and Wigham Richardson, Ltd, to the order of Rederiaktiebolaget Svenska Lloyd, of Gothenburg; dimensions, 376ft. by 50ft.; to carry 2230 tons. Engines, single-screw Parsons single-reduction steam turbines; launch, February 27th.

SARNIADOC, single-deck screw steamer; built by Barclay, Curle and Co., Ltd., to the order of Paterson Steamships, Ltd., of Canada; dimensions, 263ft. by 43ft. 4in. by 20ft.; to carry 2585 tons. Engines, triple-expansion, pressure 180 lb. per square inch; constructed by the builders; launch, February 27th.

CONTRACTS.

JOHN DAVIS AND SON (DERBY), Ltd., of All Saints' Works, Derby, have received an order from the Bolsover Company, Ltd., for the supply of miners' electric hand lamps and equipment for the new Thoresby Colliery.

CARGO FLEET IRON COMPANY, Ltd., of Middlesbrough, is manufacturing for the South African Railways some 6000 tons of rails, the greater proportion of which are being heat treated by the Sandberg sorbitic process. The same company is also heat treating rails by the same process for the Underground Railways of London.

GUEST AND CHRIMES, Ltd., of Rotherham, have recently received orders for the sluice valves and fittings required in connection with water undertakings for Plympton St. Mary, Brixton; the Birkenhead Corporation; the Bedford Corporation; the South-West Suburban Water Company; and the Wigton Rural District Council.

THE PARSONS OIL ENGINE COMPANY, Ltd., of Southampton, has received an order from John Brown and Co., Ltd., of Clydebank, to supply two 75 kW emergency generating sets, to be fitted on the new Canadian passenger liner, "Empress of Britain." These sets are to be self-contained plants, with the makers' paraffin engines, and equipped with Heenan and Froude coolers, and generators made by Messrs. Allen, of Bedford.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE BRITISH SECHERON COMPANY, Ltd., asks us to announce that it has moved its offices and works from 2, Victoria-street, S.W. 1, to 158, Stonehouse-street, London, S.W. 4, to which latter address it is requested that all correspondence shall, in future, be directed. Telephone number, Battersea 3852; telegraphic address, "Briscecolim, Clapcom, London."

BROOKES (OLDBURY), Ltd., of Oldbury, near Birmingham, asks us to announce that it has purchased the goodwill, drawings, patterns and stock-in-trade of Regent Sheet Metal Machine Tool Company, Ltd., of Wakefield, and that in future that company's products will be manufactured at the Brookes Oldbury works and marketed in its name. It also requests that all communications should be addressed Brookes (Oldbury), Ltd., Oldbury, near Birmingham. Telephone, Oldbury 70.

CITY AND GUILDS (ENGINEERING) COLLEGE.—Sir Henry Fowler, K.B.E., lectured before the Engineering Society of the City and Guilds (Engineering) College, Kensington, on Wednesday, February 27th, and was afterwards the chief guest at the annual dinner of the Society, presided over by Professor W. E. Dalby, F.R.S. During the evening the Society's Medal was presented to Mr. A. Clinton for his paper on "Aircraft Construction."

INDUSTRIAL HEATING BY GAS.—In the article on the Premix system of heating by means of producer gas, which appeared in our issue of February 15th, there are two slight typographical errors that may be confusing to some readers. In one case the consumption of electricity is given as "1849 B.Th.U." It should, of course, read 1849 B.T.U. In the other the substitution of a point for a dash may lead to the assumption that the cost of running the plant is a few pence, instead of 6s. 10d. per hour.

A GOOD SET-SQUARE.—A very ingenious transparent celluloid set-square has been sent to us by the makers, A. G. Thornton, Ltd., King-street West, Manchester. In the body of the square three springy areas are fashioned by circular grooves, the circles being not quite complete. In each of these springs a little polished stud is fastened. The result is that the set-square can be slid over the paper on the studs, but as soon as the pressure of the hand is put upon it, it flattens out on the board. Thus scribing of the paper is avoided. The squares are not expensive.

CRUX HYDRAULICA.—We have received from Hathorn, Davey and Co., Ltd., of Leeds, a copy of an enlarged form of their hydraulic calculating chart entitled Crux Hydraulica. The chart consists of two parts, one fixed and opaque, the other movable and transparent. By sliding the latter into appropriate position over the former solutions of various hydraulic problems are at once found, such problems, for example, as to find Friction Loss in a Pipe, Indicated Power, Rate of Delivery, &c., certain figures being given. The chart also lends itself to multiplication and division.

FINSBURY TECHNICAL COLLEGE, OLD STUDENTS' ASSOCIATION.—Under the genial chairmanship of Mr. E. W. Moss, M.I. Mech. E., between seventy and eighty past students of Finsbury dined together at the Trocadero on Friday last. This was the seventeenth dinner of the Association. The speeches were few, but an excellent musical programme had been arranged by Mr. Charles B. Nedand, and the evening passed very pleasantly. Mr. R. W. Paul gave the toast of the guests with just that lightness of touch that suited the occasion, and Mr. Pendred responded in a similar vein. Professor Darling then proposed the Association. In doing so, he alluded to the fact that it is just fifty years since Finsbury was established, and in view of the important position it had taken in technical education and of the eminence of the teachers who had directed it, he urged the Association to take steps to secure the facts for a history of the College before it was too late. The toast was acknowledged by Mr. Moss in a speech which was both thoughtful and amusing. Although Finsbury is no more, the old spirit is kept alive by its old students.

MATTHEW MURRAY.—The Matthew Murray Memorial Fund has recently issued a biography of Matthew Murray, who is famous as the builder of the Blenkinsop locomotive of 1812, but did a great deal of other notable mechanical engineering work. Murray was born in Newcastle, probably in 1765, and migrated, by foot, to Leeds as a journeyman mechanic, where, after spending some years with John Marshall, he joined Fenton, Wood and Lister in the establishment of an engineering works which is known to fame as Fenton, Murray and Wood, and owned the celebrated Round Foundry in Leeds. Here, in 1802 onwards Murray developed the design of a self-contained vertical engine mounted on a tank containing the condenser. In 1811 John Blenkinsop, of Brandling's Colliery, near Leeds, patented his system of hauling coal wagons by the use of a rack railway, but Murray designed the familiar locomotive that was used on the line, Middleton-Leeds, 3½ miles. Murray was also responsible for many improvements in the design of beam engines, and altogether deserves to be regarded as a pioneer engineer. The volume which lies before us consists largely of reprints of a number of publications edited by Mr. E. Kilburn Scott, but there is some original matter of importance in it. It is being published by Edwin Jowett, Ltd., Park-street, Leeds, at 2s. 6d. in paper covers and 3s. 6d. in cloth.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	17/6 to 19/-
(1) Spanish	21/-
(1) N. African	21/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	23/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 15 0	—
No. 1 Foundry	3 13 6	—
No. 3 Foundry	3 11 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 13 0	3 13 0
No. 1	3 13 6	3 13 6
Cleveland—		
No. 1	3 9 6	3 9 6
Silicious Iron	3 9 6	3 9 6
No. 3 G.M.B.	3 7 0	3 7 0
No. 4 Foundry	3 6 0	3 6 0
No. 4 Forge	3 5 6	3 5 6
Mottled	3 5 0	3 5 0
White	3 5 0	3 5 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
„ „ Foundry	3 5 0	—
(3) Northampton—		
Foundry No. 3	2 19 0	—
Forge	2 15 0	—
(3) Derbyshire—		
No. 3 Foundry	3 2 6	—
Forge	2 18 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 2 6	—
No. 4 Forge	2 18 6	—
Basic	3 2 6	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 2 6 (a) / 4 6 0 (b) / 4 9 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 5 0	—
Best Bars	10 15 0	—
Double Best Bars	11 5 0	—
Treble Best Bars	11 15 0	—
LANCS.—		
Crown Bars	10 10 0	—
Second Quality Bars	10 0 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	10 10 0	—
Best Bars	12 0 0	—
Hoops	12 10 0	—
MIDLANDS—		
Crown Bars	9 5 0 to 10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 10 0 to 8 17 6	—
Gas Tube Strip	10 12 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ½in. and up	8 7 6	7 12 6
Sections	7 17 6	7 2 6
Steel Sheets, ¼in.	8 15 0	8 12 6
Sheets (Gal. Cor. 24 B.G.)	13 10 0	13 12 6 to 13 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 15 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	7 15 0	—
Soft Billets	6 15 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 0 0	—
Light Rails	8 5 0 to 8 10 0	—
Billets	6 15 0 to 9 10 0	—
MANCHESTER—		
Bars (Round)	8 17 6	—
„ (Small Round)	8 5 0 to 8 7 6	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 12 6 to 8 17 6	—
„ (Lancs. Boiler)	9 12 6 to 9 17 6	—
SHEFFIELD—		
Siemens Acid Billets	8 15 0 to 9 0 0	—
Hard Basic	8 15 0	—
Intermediate Basic	7 5 0 to 7 15 0	—
Soft Basic	7 0 0	—
Hoops	9 5 0 to 9 10 0	—
Soft Wire Rods	7 15 0 to 7 17 6	—
MIDLANDS—		
Small Rolled Bars	7 15 0 to 8 0 0	—
Billets and Sheet Bars	6 5 0 to 6 7 6	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 12 6 to 13 15 0	—
Angles	7 17 6	—
Joists	7 17 6	—
Tees	8 17 6	—
Bridge and Tank Plates	8 12 6	—
Boiler Plates	9 15 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/- to 18/3
Block Tin (cash)	220 0 0
„ „ (three months)	222 10 0
Copper (cash)	83 10 0
„ (three months)	84 13 9
Spanish Lead (cash)	23 13 9
„ „ (three months)	23 16 3
Spelter (cash)	26 7 6
„ (three months)	26 11 3
MANCHESTER—	
Copper, Best Selected Ingots	88 15 0
„ Electrolytic	91 15 0
„ Strong Sheets	116 0 0
„ Tubes (Basis Price), lb.	0 1 3½
Brass Tubes (Basis Price), lb.	0 1 1½
„ Condenser, lb.	0 1 3½
Lead, English	25 7 6
„ Foreign	24 0 0
Spelter	26 12 6
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/8 per lb.	
	Per Ton.	Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/6
„ „ 6 p.c. to 8 p.c.	£20 12 6	7/-
„ „ 8 p.c. to 10 p.c.	£20 10 0	6/-
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£32 0 0	12/-
„ „ „ 1 p.c. carbon	£37 0 0	15/-
„ „ „ 0·70 p.c. carbon	£42 0 0	17/-
„ „ „ carbon free	1/- per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home	
	£13 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
„ „ 75 p.c.	£19 0 0 scale 6/- per unit	
„ Vanadium	13/6 per lb.	
„ Molybdenum	3/8 per lb.	
„ Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	10/- per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	16/6
„ „ Ell	19/-
„ „ Splint	18/6 to 19/6
„ „ Trebles	17/6
„ „ Doubles	16/-
„ „ Singles	14/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	17/6
„ „ Jewel	18/6
„ „ Trebles	17/6
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	17/- to 18/6
Screened Navigation	19/6
Trebles	17/6 to 18/6
Doubles	17/- to 17/6
Singles	15/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	16/6
Secondary Steam	16/-
Trebles	17/6
Doubles	16/6
Singles	14/9

ENGLAND.

(8) N.W. COAST—	
Steams	23/-
Household	39/6 to 52/-
Coke	23/-
NORTHUMBERLAND—	
Best Steams	16/6
Second Steams	15/6 to 16/-
Steam Smalls	10/6 to 11/-
Unscreened	14/-
Household	21/- to 27/-
DURHAM—	
Best Gas	15/- to 15/3
Second	14/6 to 14/9
Household	21/- to 27/-
Foundry Coke	22/6 to 25/-
SHEFFIELD—	Inland.
Best Hand-picked Branch	27/- to 28/6 —
Derbyshire Best Bright House	23/6 to 25/- —
Best House Coal	21/- to 22/- —
Screened House Coal	18/- to 19/- —
„ „ Nuts	17/- to 19/- —
Yorkshire Hards	15/6 to 16/6 —
Derbyshire Hards	15/6 to 16/6 —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	6/- to 7/- —
Smalls	3/6 to 4/- —
Blast-furnace Coke (Inland)	14/6 at ovens —
Furnace and Foundry Coke (Export), f.o.b.	20/6 to 21/6

(9) SOUTH WALES.

CARDIFF— Steam Coals:	
Best Smokeless Large	20/6 to 21/-
Second Smokeless Large	19/6 to 20/3
Best Dry Large	19/6 to 20/-
Ordinary Dry Large	19/- to 19/6
Best Black Vein Large	19/9 to 20/-
Western Valley Large	19/3 to 19/9
Best Eastern Valley Large	19/- to 19/3
Ordinary Eastern Valley Large	18/6 to 19/-
Best Steam Smalls	14/- to 14/6
Ordinary Smalls	13/- to 13/6
Washed Nuts	20/- to 24/-
No. 3 Rhondda Large	21/- to 22/-
„ „ Smalls	15/- to 16/-
No. 2 „ Large	18/6 to 19/-
„ „ Through	17/- to 18/-
„ „ Smalls	13/6 to 14/-
Foundry Coke (export)	27/- to 37/-
Furnace Coke (export)	19/- to 21/-
Patent Fuel	20/- to 21/6
Pitwood (ex ship)	27/- to 27/3
SWANSEA— Anthracite Coals:	
Best Big Vein Large	33/- to 35/-
Seconds	25/- to 29/-
Red Vein	22/- to 27/-
Machine-made Cobbles	40/- to 43/6
Nuts	36/- to 43/6
Beans	23/6 to 25/-
Peas	16/6 to 17/6
Breaker Duff	9/- to 9/6
Rubbly Culm	10/9 to 11/3
Steam Coals:	
Large	18/- to 19/-
Seconds	17/- to 18/-
Smalls	11/- to 12/9
Cargo Through	15/9 to 16/9

(1) Delivered. (2) Net Makers' Works. (3) f.o.t. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (d) Rebate 12/6 joists and 10/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our Correspondent in Paris.)

Transport and Trade.

EVENTS of the past month have shown that while inland waterways may possess advantages in cheapening the transport of raw material in bulk, they also have drawbacks. The freezing of canals and rivers caused serious trouble to works and factories, many of which had practically to cease operations. Many manufacturers suffered losses through an interruption of operations when they were exceptionally busy, and the stoppage has left an accumulation of work which is occupying everyone to their full capacity. In many cases it is difficult to place new orders for delivery within a reasonable time. The railway companies are preparing to give out important orders for rolling stock. The State Railways will soon be inviting tenders for the supply of 2000 wagons. The Algerian Railways have ordered from the Socétié de Dietrich fifty trucks to be fitted with Clayton-Hardy vacuum brakes. The question of automatic couplers is also coming again to the fore. The Public Works' Commission of the Chamber of Deputies is not satisfied with the statement of the Minister of Public Works to the effect that the railway companies do not consider themselves justified in going to the expense of equipping their rolling stock with automatic couplers, and a Bill is to be introduced requiring the companies to fit all their coaches and trucks with such apparatus by the end of 1941 at the latest, but as the order is provisional on an international arrangement being come to, the Bill merely establishes a principle which may not become effective within the period named.

The Alsace Canal.

As work continues on the first section of the Alsace Canal it is hoped that there will be a weakening of the opposition from Switzerland, where the importance of the canal will be so far recognised that there will be no necessity to proceed with the canalisation of the Rhine. It is obvious that if navigation on the Rhine is facilitated it will diminish the importance of the Alsace Canal as an international waterway. Hence, the French hope to convince the Swiss that the Rhine scheme is illusory, and may cost far more than is estimated, while the expense involved in keeping the river open will always be heavy. So far, the question has been discussed with a political bias, and the Swiss and Germans have adopted a decidedly hostile attitude towards the canal. The scheme for regularising the Rhine has been fully developed and work has been started upon and barrages constructed. Nothing definite has, however, yet been done in the way of carrying out the undertaking in its entirety, although Germany is urging it forward and offers to contribute 40 per cent. of the cost and to maintain the works on its side of the river. The Swiss now affirm that, if they favour the proposal to improve the navigation of the Rhine, it is because the works can be carried out within a period of ten years, while it is probable that the Alsace Canal will not be completed within thirty years. Therefore Basle would gain by a canalisation of the river. The French argue that the promoters of the Rhine scheme are likely to be seriously mistaken in their calculations, and it is difficult to see how any system of canalisation will prevent the silting up of the river bed. As for the time taken to construct the canal, it is true that the Kembs section may not be completed within four years, but that includes the work of organisation and the construction of the barrage across the Rhine, so that the time occupied on the other seven sections will be greatly reduced. On the whole, it does not appear probable that the discussion will prevent the carrying out of the Rhine canalisation scheme, but its execution depends upon the financial support of Switzerland.

Foreign Trade.

If the continued decline of foreign trade were not to be explained in part by industrial activity at home, the monthly returns showing continually diminishing exports would be regarded with serious concern, but even the activity at home does not explain everything, and there are many factors in the economic situation that offer little hope of improvement. This country was one of the first to start upon a policy of raising import duties for the protection of home industries, and now that other countries have done the same thing, at a time when France is less able to compete in foreign markets, the outlook is distinctly unsatisfactory. The returns for January show that imports were valued at 5173 million francs, an augmentation of 1095 millions as compared with the first month of 1927, and the values of exports were 3701 million francs, a decline of 317 million francs. The imports of manufactured goods were nearly three times that for January last year. As regards exports there was a declension of raw material, both in quantity and value, and, while the exports of manufactured goods increased, there was a considerable falling off in value.

Air Services.

Coinciding with the presentation of a programme by the Air Minister, Monsieur Laurent d'Eynac, for a reorganisation of the air services, there were two failures to effect flights between France and Indo-China. Coste came to grief a few miles from the start and Paillard succumbed when within a few hours of Saigon, both events being attributed to engine troubles. This has strengthened the feeling that something must be done to reinstate French aviation, which is regarded as having fallen behind that of other countries in the organisation of commercial services. It is proposed to amalgamate and reconstruct the existing companies, so as to constitute three concerns to carry out the services :—(*a*) In Central and Northern Europe ; (*b*) between London and Marseilles and the line to Indo-China ; and (*c*) between Africa and South America. Manufacturing interests will be entirely eliminated, and the State and the railway companies will have a financial participation in the undertakings.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

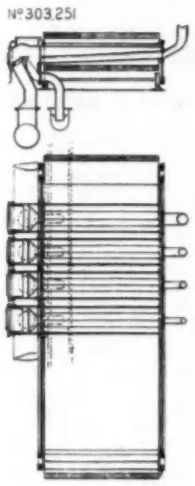
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application ; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

303,251. November 26th, 1927.—BOILER ASHPITS, A. W. Bennis, Little Hulton, Bolton.

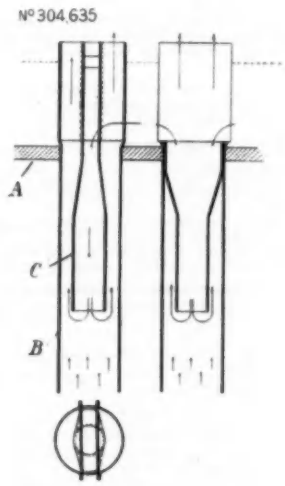
This invention practically boils down to the flushing of the air and ash cells of a compartment travelling stoker, with water in a progressive fashion, so that those cells near the front of the



furnace are not so copiously watered as those towards the rear. The water would have a cooling and humidifying effect on the grate, but the inventor does not specify the precise extent of its variation from cell to cell. The drawing, however, indicates the magnitude of the water supplies intended at the various branches.—*January 3rd*, 1929.

304,635. October 22nd, 1927.—STEAM GENERATORS, F. L. Duffield, 11, Aldwych, London, W.C. 2.

The general arrangement shows that this boiler is of what may be described as the box type, with water-tubes depending from overhead drums. The chief interest lies in the pro-

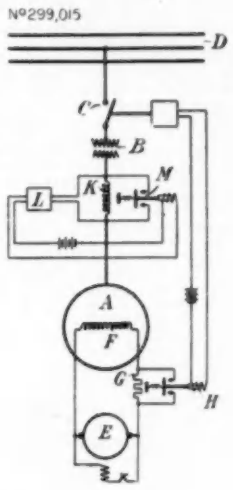


vision of "Field tubes" within the upper part of the water-tubes, the object being to accelerate the water circulation in that part of the tubes subject to the greatest heat of the furnace. In the drawing the wall of the drum is shown at A, one of the steam generating tubes at B, and the Field tube at C. —*January 22nd*, 1929.

DYNAMOS AND MOTORS.

299,015. October 18th, 1928.—PROCESS FOR SYNCHRONISING SYNCHRONOUS MACHINES, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

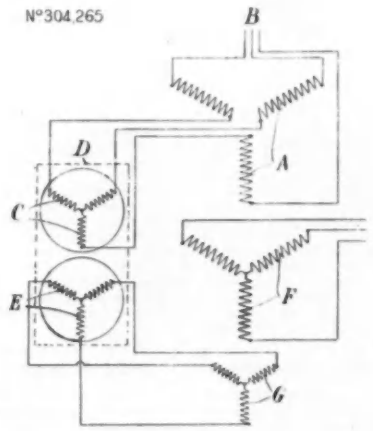
The synchronous generator A is to be connected up through the transformer B and the main switch C to the three-phase mains D. E is a self-excited exciting generator, coupled to the synchronous generator, which feeds the exciting current circuit F of the generator. G is an ohmic resistance in this exciting current circuit, which, when fully in circuit, reduces the excitation of the machine A to from 10 to 20 per cent. of the normal excitation. H is a relay subordinate to the switch C, which short circuits the resistance G when the switch is closed. K are the choking coils in the circuit of the synchronous machine. The generator A, coupled, for instance, to a water turbine, is, first of all, brought up to a speed of rotation approaching synchronism, its excitation being meantime reduced by the switching in of the resistance G. The switch C is then closed, so that the machine A passes, with oscillations, into the synchronising state. Simultaneously with the closing of the switch C the excitation of the machine A is increased by the short circuiting of the resistance G. This increase does not take place instantaneously, but subject to a time constant, which is in essence given by the inductivity and the ohmic resistance of the exciting circuit. The gradual growth of the excitation can be influenced within wide limits by the value of the resistance G switched out by short circuiting. A relay L is provided to effect the automatic switching out of the choking coils K at the right time, viz., at the end of the oscillating-in period of the machine A. This relay is controlled by the voltage on the choking coils K, and, on that voltage falling below a certain value, the choking



coils are cut out by a short circuiting switch M. Since, during the oscillating period, the current flowing through the choking coils does not diminish regularly, but by succeeding oscillations, the relay L is provided with a retarding device which levels out the effect of these oscillations, and prevents a premature operation of the relay by a current produced by the succeeding oscillations.—*January 24th*, 1929.

304,265. October 18th, 1927.—IMPROVEMENTS IN OR RELATING TO ELECTRICAL INDUCTION VOLTAGE REGULATING SYSTEMS, Anthony Browne, of 30, Fox-hill, Upper Norwood, London.

This invention relates to electrical induction regulating systems operating by variation of voltage and is more particularly applicable to polyphase transformers or other apparatus having star connections and intended to operate at high voltage. The outer ends of the primary windings A are connected to the three-phase mains B, but the inner ends of the windings A, instead of being connected to a star point, are joined to the outer ends of star-connected stator windings C of the induction regulator D, the inner ends of the windings C being connected together to a star point which may be earthed. It will be seen that the voltage existing between the windings C and between

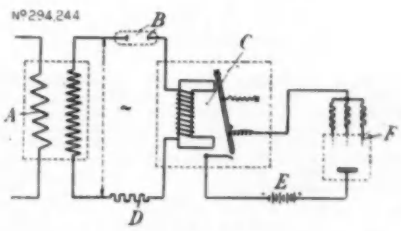


any of these windings and earth will be very much less than if the stator windings were respectively connected between the windings A and the mains B, and therefore the necessity for the heavy insulation hitherto demanded is dispensed with. As regards the rotor windings E, these might be respectively connected to the secondary windings F of the transformer or excited in any other suitable manner, but, in order to reduce the voltage across the rotor windings, they may be connected as indicated, to an auxiliary secondary winding G excited from the main primary winding A. It will be seen that with the arrangement described, regulation may be effected as satisfactorily as in the case of the system normally adopted, and that the above-mentioned advantages resulting from lower voltage across the regulator stator and rotor windings are secured.—*January 18th*, 1929.

ELECTRICAL APPLIANCES.

294,244. July 10th, 1928.—APPARATUS FOR EXTINGUISHING BACK IGNITIONS IN MERCURY VAPOUR RECTIFIERS, Aktiengesellschaft, Brown, Boveri et Cie., of Baden, Switzerland.

This invention relates to a relay for the grid control of mercury

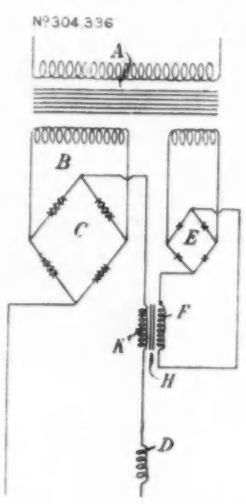


vapour rectifiers for extinguishing back ignitions by connecting up a negative voltage to the anode grids. For rendering the grid control of rectifiers effective, a quick-acting relay which becomes operative without any time lag on back ignitions

or short circuits occurring is required. In the drawing A is a transformer, the primary of which is connected to the network phases of the feeding transformer. The secondary winding feeds the glow tube B. In series with the tube is the exciter coil of the switching magnet C and a resistance D. The spring loaded armature of the magnet C controls the circuit by which the voltage of the continuous current source E is connected to the anode grid F of the rectifier. The current, which is dependent on the magnitude of the load of the feeding transformer of the rectifier, produces on the secondary side of the transformer A an alternating current voltage, the amplitude of which at full load is smaller than the voltage of the glow of the tube B. The resistance of the latter when inoperative is infinitely great, and the secondary circuit of the transformer carries no current. When the load current rises to a predetermined value there will be a momentary glow discharge of the tube B and its resistance will drop to a small amount. The switching magnet C attracts its armature and thereby connects the negative pole of the continuous current source E to the anode grid F. The transformer A may be so constructed that it will soon be saturated in order to protect the glow tube on an excessive load occurring. The alternating current from the transformer secondary winding may be rectified by any known form of rectifier prior to its passage through the glow tube and relay coil circuit.—*January 31st*, 1929.

304,336. July 20th, 1927.—IMPROVEMENTS RELATING TO ELECTRIC CURRENT RECTIFYING APPARATUS, Leslie Hurst Peter and the Westinghouse Brake and Saxby Signal Company, Ltd., both of 82, York-road, King's Cross, London.

In accordance with this invention, the alternating current traversing the secondary winding B of the main transformer A is converted, in the rectifying system C, into unidirectional pulsating current. The rectified half waves of the alternating current as modified by the presence of the inductance D constitutes a unidirectional current of rippled or undulatory wave form, which may be regarded as comprising two component currents, namely, a direct current of constant value and an alternating current component representing the ripple of the

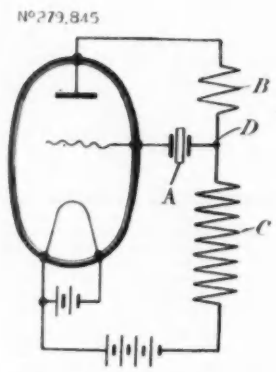


wave form. The unidirectional pulsating current derived from the second rectifying system E is of similar form, and as that current is supplied to the primary winding F of the smoothing transformer H, the secondary winding K of which is traversed by alternating current corresponding to the ripple component of the current in the primary winding F, but of opposite phase, the alternating current is superposed in the direct-current circuit on the rippled unidirectional current supplied from the first rectifying system C, with the result that the alternating current supplied from the secondary winding F of the smoothing transformer H can be arranged to neutralise or to oppose wholly or partly the ripple component of the current supplied to the direct-current circuit by the first rectifying system C.—*January 21st*, 1929.

TELEGRAPHS AND TELEPHONES.

279,845. October 24th, 1927.—DEVICES FOR GENERATING ELECTRICAL OSCILLATIONS BY MEANS OF PIEZO ELECTRICAL CRYSTALS, *Radiofrequenz Gesellschaft mit beschränkter Haftung, of 5, Niedstrasse, Berlin-Friedenau, Germany.*

This specification describes a simple method of producing oscillations by means of a three-electrode valve and a piezo-electric crystal. A quartz crystal A in the form of a disc is placed between two plates and connected in the grid circuit as



shown. Experiments have shown that the arrangement oscillates easily and effectively if the natural oscillation of the coil B approximates the natural oscillation of the quartz resonator A. To produce different frequencies, the connecting point D is adjusted between the two coils B and C, so that the part of the coil more closely connected to the anode has a natural oscillation corresponding to the frequency to be generated.—*January 24th*, 1929.

MISCELLANEOUS.

304,623. October 20th, 1927.—THE MANUFACTURE OF LIQUID OR SOLID PRODUCTS BY GASEOUS REACTION UNDER THE INFLUENCE OF SILENT ELECTRICAL DISCHARGE, *A. Carpmael, 24, Southampton-buildings, London, W.C. 2.*

The claims in this specification seem to be of a very far-reaching nature, but appear from the context to be primarily applicable to the manufacture of hydrogen peroxide by synthesis. It is suggested that the reaction in the working chamber may be retarded by the deposition on its walls of the product desired, so the process is carried on in such circumstances that the cooling fluid of the discharge chamber is controlled so that the temperature is allowed to rise above the saturation point of the gas mixture in order to prevent or minimise deposition of the reaction products on the walls of the chamber. Alternatively the gas mixture is diluted to such an extent as to ensure working below the saturation point so that the products are carried away from the sphere of action. Several experimental examples of the working of the invention are described in the specification, and among them there is the following :—A glass discharge tube of 1250 mm. length is employed of a width of 6 mm., the tube is worked by alternating current of 50 cycles with 18,000 volts. A hydrogen-oxygen mixture containing 3 per cent. of oxygen is passed through at a speed of 100 litres per hour, the tube consumed 160 watts and yielded per hour 1·18 grams of hydrogen peroxide at a total consumption of energy of 136 kilowatt hours per kilogram of hydrogen peroxide. If now whilst maintaining all other conditions the condensation within the tube is prevented by diluting the gas mixture with seven times the volume of the same hydrogen, and correspondingly increasing the speed of gas mixture to 800 litres per hour, the performance of the tube was raised to 1·52 grams of hydrogen peroxide per hour, whilst the energy consumption was reduced to 108 kilowatt hours per kilogram of hydrogen peroxide.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTE OF METALS : SHEFFIELD LOCAL SECTION.—Non-Ferrous Section of the Applied Science Department, The University, St. George's-square, Sheffield. "Progress in Electric Furnaces," by Messrs. D. F. Campbell and W. S. Gifford. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS : SCOTTISH CENTRE.—In the Cowdray Hall, Aberdeen. The Faraday Lecture, "How Electricity Does Things," by Mr. Ll. B. Atkinson. 8 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Chairman's address, "Road Transport," by Mr. S. H. Hole. 7.30 p.m.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Room 14, Temperance Institute, Keighley. Lecture, "Centrifugal Castings," by Mr. H. G. Springfield. 7.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Engineers' Club, 17, Albert-square, Manchester. "Improvements in Driving Textile Mills," by Mr. F. B. Holt. 7.15 p.m.

PHYSICAL SOCIETY.—At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. "The Dependence of the Mobility of Ions in Air on the Relative Humidity," by Mr. Ezer Griffiths, F.R.S., and Mr. J. H. Awbery ; "Some Unsolved Problems Relating to the Mobilities of Gaseous Ions," by Professor A. M. Tyndall. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "The Place of Women in Later Mediæval Civilisation," by Professor T. F. Tout. 9 p.m.

SATURDAY, MARCH 9TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Town Hall, Sheffield. Yorkshire District Meeting. Paper, "The Local Government Act and the Municipal Engineer," by Mr. W. J. Hadfield. 1 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "Molecular Motions in Rarefied Gases," by Sir Ernest Rutherford, F.R.S. 3 p.m.

MONDAY, MARCH 11TH.

INSTITUTE OF METALS : SCOTTISH LOCAL SECTION.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Open discussion. 7.30 p.m.

INSTITUTE OF TRANSPORT.—In the Lecture Theatre of the Institution of Electrical Engineers, Victoria Embankment, W.C. 2. "The Froelich Hydraulic Wagon Brake at March Concentration Yard," by Mr. H. N. Gresley. 5.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Queen's Hotel, Birmingham. "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles," by Mr. H. Kerr Thomas. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS : YORKSHIRE BRANCH.—Hotel Metropole, Leeds. Joint discussion with the Society of Chemical Industry on "Hardness." 7.15 p.m.

TUESDAY, MARCH 12TH.

INSTITUTE OF BRITISH FOUNDRYMEN : LANCASHIRE BRANCH—BURNLEY SECTION.—The Lecture Room of the Municipal College, Burnley. "The Cupola," by Mr. A. Jackson. 7.15 p.m.

INSTITUTE OF MARINE ENGINEERS.—In the Lecture Hall of the Institute, 85/88, The Minories, E. 1. "Merchant Ship Service Performance Analysis," by Dr. E. V. Telfer. 6.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS : LONDON GRADUATES.—At Watergate House, Adelphi, W.C. 2. "Metal Omnibus and Car Bodywork," by Mr. D. Swallow. 7.25 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Rover Sports Club, Albany-road, Coventry. General meeting. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. Paper to be further discussed, "Impact in Railway Bridges, with Particular Reference to the Report of the Bridge Stress Committee," by Mr. Conrad Gribble. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS : NORTH MIDLAND CENTRE.—Hotel Metropole, Leeds. Annual dinner. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS : SCOTTISH CENTRE.—The North British Station Hotel, Edinburgh. "The Construction of the Grid Transmission System in Great Britain," by Messrs. Johnstone Wright and C. W. Marshall. 7 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow. Paper, "Pulverised Fuel Today," by Engineer-Captain J. C. Brand. 7.30 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Drilling for Oil with a Diamond Drill," by Mr. G. Heseldin. To be read by Mr. A. E. Chambers. 5.30 p.m.

WEDNESDAY, MARCH 13TH.

INSTITUTE OF FUEL.—In the rooms of the Chemical Society, Burlington House, Piccadilly, London, W. 1. "The Industrial Uses of Gas," by Mr. F. W. Goodenough. 6 p.m.

INSTITUTE OF METALS.—Trocadero Restaurant, Piccadilly Circus, W. 1. Annual Dinner and Dance. 6.45 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. Subject for discussion, "Bonding and Anchorage of Reinforcing Steel in Concrete," by Mr. Haddon Clifford Adams. 6 p.m.

INSTITUTION OF ENGINEERS-IN-CHARGE.—St. Bride Institute' Bride-lane, Fleet-street, E.C. 4. "Recent Developments in Superheating," by Mr. J. S. Evenden. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS : YORKSHIRE BRANCH.—Grand Hotel, Sheffield. Discussion on paper, "Points of Metallurgical Interest to Engineers," by Mr. A. P. Hague. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the premises of Holophane, Ltd., Elverton-street, S.W. 1, and Lecture with demonstrations of general and colour lighting. 7 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS : GRADUATE SECTION.—Bolbec Hall, Newcastle-on-Tyne. "The Problem of High Voltage Measurement," by Mr. M. Waters. 7.15 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "Loud Speakers and their Development," by Mr. Roderick P. G. Denman. 8 p.m.

WEDNESDAY AND THURSDAY, MARCH 13TH AND 14TH.

INSTITUTE OF METALS.—Institution of Mechanical Engineers, Storey's-gate, Westminster, London, S.W. 1. Twenty-first annual general meeting. For programme see page 130. 10 a.m. each day.

THURSDAY, MARCH 14TH.

BRITISH ASSOCIATION OF REFRIGERATION.—In the Hall of the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W. 1. Adjourned discussion. "The Industrial Value of Technical Engineers," by Sir William B. Hardy, F.R.S. 5.30 p.m.

INSTITUTE OF METALS.—Science Museum, Exhibition-road, S. Kensington, S.W. 7. Conversazione and Exhibition. Reception 8 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—In the Lecture Theatre of the Institution, Savoy-place, Victoria Embankment, W.C. 2. "Electrical Insulating Papers for the Manufacture of Power Cables," by Dr. T. N. Riley and Dr. T. R. Scott ; and "The Prevention of Ionisation in Impregnated Paper Dielectrics," by Mr. S. G. Brown and Mr. P. A. Sporing. 6 p.m.

INSTITUTION OF ENGINEERING INSPECTION.—At the Hotel Cecil, London, W.C. 2. Annual dinner. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS : NORTH-WESTERN BRANCH.—Engineers Club, Manchester. "The Supermiser—a Combined Air Heater and Economiser," by Dr. T. B. Morley. 7.15 p.m.

INSTITUTION OF MECHANICAL ENGINEERS : YORKSHIRE BRANCH.—Hotel Metropole, Leeds. Discussion on paper, "Points of Metallurgical Interest to Engineers," by Mr. A. P. Hague. 7.30 p.m.

OPTICAL SOCIETY.—At the Imperial College of Science and Technology, Imperial Institute-road, South Kensington, S.W. 7. Annual general meeting, 7.30 p.m. ; at 8 p.m., ordinary meeting. The following papers will be presented and discussed :—"A Re-determination of the Trichromatic Coefficients of the Spectral Colours," by Mr. W. D. Wright ; "On the Testing of a Novel Photographic Shutter," by Dr. John S. Anderson. 8 p.m.

FRIDAY, MARCH 15TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London, S.W. 1. "Research in Mechanical Engineering by Small-scale Apparatus," by Mr. F. C. Johansen. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Informal meeting. "Locomotive Rating," by Mr. T. Grime. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Bolbec Hall, Newcastle-upon-Tyne. "Mechanical and Transmission Losses in Marine Engines, Shafting and Propellers," by Mr. J. Hamilton Gibson. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, London, W. 1. Discourse, "The Distribution of the Chemical Elements," by Professor V. M. Goldschmidt. 9 p.m.

SATURDAY, MARCH 16TH.

INSTITUTION OF CIVIL ENGINEERS.—Students' visit to the Fuel Research Station, East Greenwich.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS. South Midland District Meeting at Uxbridge, Middlesex. 10.30 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South-Western District, Guildhall, Bath. Annual District Meeting. 11 a.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, London, W. 1. "Molecular Motions in Rarefied Gases," by Sir Ernest Rutherford, F.R.S. 3 p.m.

MONDAY, MARCH 18TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London, S.W. 1. Graduates' Section, London. "Locomotive Lubrication," by Mr. Keith Brinsmead. 6.30 p.m.

TUESDAY, MARCH 19TH.

ILLUMINATING ENGINEERING SOCIETY.—At the E.L.M.A. Lighting Service Bureau, 15, Savoy-street, Strand, W.C. 2. "Architectural Lighting," by Mr. Waldo Maitland. 6.30 p.m.

INSTITUTE OF METALS : BIRMINGHAM LOCAL SECTION.—The Engineers' Club, Waterloo-street, Birmingham. "Aluminium." by Dr. N. F. Budgen. 7 p.m.

INSTITUTE OF METALS : NORTH-EAST COAST LOCAL SECTION.—Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Annual General Meeting and Exhibition of Metallurgical Preparations and Products. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1. Inventors' evening. 7.45 p.m.

THURSDAY, MARCH 21ST.

INSTITUTION OF AUTOMOBILE ENGINEERS : WESTERN CENTRE.—Technical School, Gloucester. "The Inspection of Metals and their Alloys," by Mr. L. W. Johnson. 7.30 p.m.

FRIDAY, MARCH 22ND.

INSTITUTION OF LOCOMOTIVE ENGINEERS : NORTH-EASTERN CENTRE.—Hotel Metropole, Leeds. "Experiments on Buffer Springs," by Mr. T. Robson. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—At 39, Victoria-street, S.W. 1. Informal meeting. "Ventilation," by Mr. D. A. Collin. Slides and demonstrations. 7.30 p.m.

SATURDAY, MARCH 23RD.

CHELSEA POLYTECHNIC.—Manresa-road, London, S.W. 3. Conversazione. 3 p.m.

MONDAY, MARCH 25TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W. 1. Graduates Annual Lecture, "Aircraft Engineering in its Relation to Mechanical Engineering,' by Wing-Commander T. R. Cave-Browne-Cave. 6.30 p.m.